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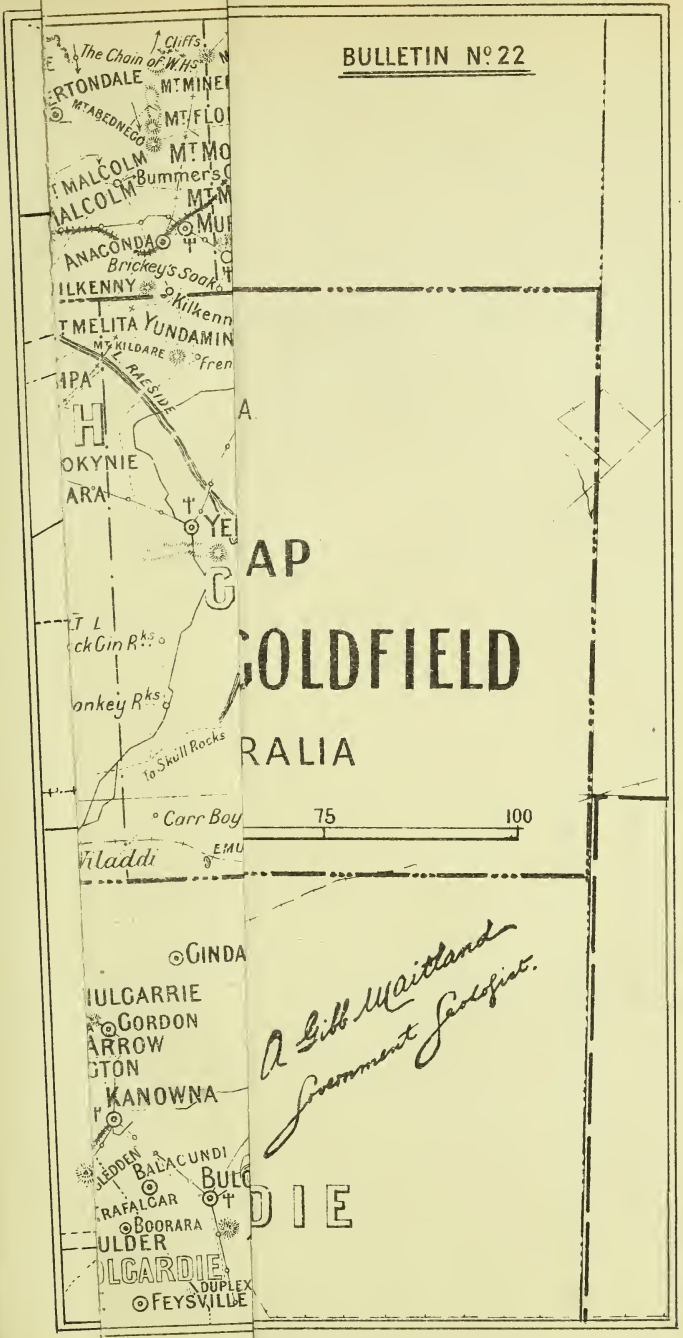

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THE AURIFEROUS DEPOSITS AND MINES OF MENZIES,

NORTH COOLGARDIE GOLDFIELD,

BY

HARRY P. WOODWARD,

Assistant Government Geologist.

Issued under the authority of the Hon. H. Gregory, M.L.A., Minister for Mines.

WITH TWO MAPS AND SIX PLATES OF SECTIONS.

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1906.

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PREFATORY NOTE.

THIS report upon the Auriferous Deposits and Mines of Menzies, by Mr. H. P. Woodward, forms another of the series designed to treat of the different mining centres of the State.

The geological work was based upon the topographical map prepared by Mr. W. D. Campbell in the year 1899. The existence of this map greatly facilitated Mr. Woodward's work, and it is much to be regretted that it has not hitherto been found possible to have the necessary topographical work completed and available before the geological surveys of important mining centres are undertaken. The preparation of the topographical map of Menzies involved a good deal of labour, necessitating the fixing of all shafts, etc., in addition to running contour lines 10 feet apart in altitude ; the survey was carried out with a four-inch tacheometer, and as a check a few measurements were made with a chain. In order to preserve continuous contour lines, the survey was carried a little further than would otherwise have been the case.

The area embraced by Mr. Woodward's work covers about 50 square miles, and includes the productive area of the district so far as at present understood. The field work, upon which Mr. Woodward's geological and mining work is based, was commenced in May and concluded on the 20th of October, 1905, but owing to the necessity for him remaining in touch with the Perth office during my absence in the North-West, and in paying short visits to different portions of the State for specially urgent purposes, the Menzies survey could not be carried out continuously.

In its essential geological features, Menzies consists of a complex of basic rocks, through which have been intruded a series of acidic dykes, which in all probability emanated from the large granitic mass which forms the higher ground in the vicinity of Springfield, near the eastern border of the map.

The ubiquitous cover of superficial deposits has rendered geological mapping somewhat difficult, but so far as possible the different rock masses and associated ore deposits have been delineated on the geological map with such a degree of accuracy as the scale of the field plans would admit.

The basic crystalline rocks of Menzies are of considerable importance, as they are everywhere genetically connected with the

auriferous quartz reefs of the district; they consist for the most part of amphibolite and diorite, and their derivatives: serpentine, chlorite, and hornblende schists. Many of the more or less foliated or quasi-schistose basic rocks, when followed down to about 100 feet or so below the surface, gradually give place to massive greenstones, which, however, when exposed to the weather, rapidly become fissile and split readily along cleavages planes. This dormant foliation has been proved to exist to the greatest depths yet attained on the field, viz., 800 feet.

The acidic rocks only occupy a relatively small area of the surface in the vicinity of Springfield, though their existence beneath the superficial cover has been proved in wells and quarries to the north and west. They consist chiefly of gneiss, mica schist, sericite schist; and, as is the case with the basic rocks, the schistose character seems to be lost at a variable depth below the surface. There seem good reasons for believing that this mass consists of a porphyritic granite, which owes its present condition to crushing and hydration. A portion of the field is traversed by numerous acidic dykes, some of which are of considerable horizontal extent; they are generally represented by sericite schists and allied rocks, though transitions from such to porphyritic granite have been noticed.

The quartz reefs, which are confined to the greenstones, are of various types and of somewhat different characters. Several large banded quartz reefs, approaching quartzite in appearance, occur in certain localities; they are, however, of no extent, nor are they of any economic importance.

Some very ferruginous lodes which, below water-level often pass into marcasite, are met with, and can be traced for considerable distances; whilst these deposits have proved to be auriferous, they have invariably been found to be of so low a grade as to be unworkable.

Most of the gold from Menzies has been obtained from segregation reefs, which have an irregular lenticular habit. One of the longest of these is 1,600 feet, though with the exception of those in the few larger mines, these segregation reefs do not attain any great longitudinal extent, but form a series of small but rich parallel veins.

One or two fissure-veins occur in the field, but the comparative poverty of their gold contents is more than compensated for by their extent and the probabilities of continuity in depth.

Every available mine on the field was visited by Mr. Woodward during the course of his work, but many of the larger properties were shut down and inaccessible. Full and detailed descriptions of the mines, accompanied by mining plans, without which the text would be wellnigh unintelligible, are given *in extenso* in the report.

Statistics of the production of the district are attached to the descriptive portions, and in the form in which they are represented the figures give as complete a record of the gold yield of the various deposits of Menzies as is possible. These demonstrate that from the area embraced by the Geological Map of Menzies there have been produced 403,787·71 fine ounces of gold, derived from the milling of 348,967·40 tons of quartz, or at the rate of 1·15 fine ounces per ton.

The deposits so far opened up have not been, below the depth of 300 feet, as satisfactory in regard to both quantity and quality of the ore as in the higher levels. Although many of the larger ore deposits appear to have been virtually worked out, there seems every reason to believe that other deposits of a somewhat similar nature to the smaller veins already opened up in many of the old workings may be reasonably expected to be discovered by judicious exploration, and may prove possibly of equal value.

The report and accompanying maps were, on being submitted to the Hon. the Minister for Mines, ordered to be printed for public information.

The index to names, places, mines, reefs, etc., occurring in the report has been prepared by Mr. P. J. Atkins, Clerk to the Geological Survey.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Perth, 12th April, 1906.

The Auriferous Deposits and Mines of Menzies,

NORTH COOLGARDIE GOLDFIELD.

Introduction.

This report is accompanied by a geological and topographical map of the district around the town of Menzies, also a plan showing the underground workings, lodes, cross-courses, etc., of the principal mines, and has been divided into sections under the following heads:—

I. *General.*—A description of the position of the area under review, with its discovery, history, and annual production of gold from 1896 to 1905.

II. *Topography.*—A short general description of the physical features of the district.

III. *Water Supply.*—A description of the sources from which it is obtained, and its character, with a rainfall table for the preceding nine years.

IV. *Descriptive Geology.*—A short description of the nature of the various rocks, dykes, reefs, and faults.

V. *Economic Geology.*—A short description of the various mines, with the quantity of gold yielded by each lease in the district since its discovery.

VI. *Conclusion.*

Appendix I.—Synoptical Table showing the yield of the Leases at Menzies up to the end of 1905.

Appendix II.—List of Rocks in the Geological Survey Museum, collected in the Menzies District.

General.

Menzies is situated in the North Coolgardie Goldfield, longitude 121 degrees, S. lat. 29 degrees 40 minutes, at an altitude of 1,403 feet above the sea-level, being connected with Perth and Fremantle by a railway line 467 miles in length *via* Kalgoorlie.

In a Handbook of the North Coolgardie Goldfield, compiled by Mr. J. McIntyre and published by the *Herald*, at Menzies, in 1899, it is stated:—

"L. R. Menzies, after whom the district is named, and J. McDonald (representatives of a Perth syndicate) applied on the 1st

October, 1894, for the first lease in what is now known as the Menzies district. They were not, however, the first prospectors. A well-equipped party came from the 90-mile (Goongarrie) in August of that year, consisting of J. Brown, C. Kirby, and C. Jackman, and had, to a certain extent, developed a show about two miles south of the lease Messrs. Menzies and McDonald applied for. It did not turn out as expected, and the lease was not at that time applied for, though afterwards it was taken up and called the 'Pioneer' (Lady Harriet). The lease, however, which Menzies obtained was the world-famed 'Lady Shenton,' the leading mine of the district."

Owing to the richness of the early discoveries, this district rapidly attracted considerable attention in the mining world, with the result that numerous companies were floated and large areas applied for as leases. Unfortunately, however, the rich properties were limited, and, more unfortunately still, the lodes in these, after yielding a considerable quantity of gold, have, with a few exceptions, decreased so considerably in size and richness in their lower levels that work has been practically suspended.

Up to the end of the year 1905 over 400,000ozs. of gold were obtained from this district, of which total over seven-eighths were produced by seven Companies, the properties of five of which have now practically ceased to be productive. In spite of this fact it is most satisfactory to note that the gold returns from this district have not fallen off as considerably as might have been expected, this being due to the large number of small rich shows that have been developed by working miners since the establishment of a State Battery.

The following is a statement of the gold yield from this district, from its inception up to the end of 1905, as reported to the Mines Department:—

*Table showing the Annual Yield of Gold from the Menzies District.**

Year.	Ozs. crushed.	Gold therefrom.	Rate per ton.
	tons.	fine ounces.	ozs.
Prior to 1897	8,472	17,135·24	2·02
1897	26,181·35	45,979·54	1·75
1898	24,114·00	45,691·80	1·89
1899	38,283·05	50,076·01	1·30
1900	34,066·75	39,720·09	1·16
1901	38,202·25	43,831·80	1·14
1902	43,945·50	47,080·63	1·07
1903	51,782·35	47,929·20	·92
1904	41,984·85	31.146·12	·74
1905	41,935·30	35·197·28	·84
Total	**348,967·40**	**403,787·71**	**1·15**

* This table includes only the returns from those leases which are embraced by the area of the Geological Map.

PART I.—General Geology.

Section I.—Topography.

The area under review surrounds the township of Menzies, covering about 50 square miles, the survey of which was carried out by Mr. W. D. Campbell, Assoc.M.Inst.C.E., F.G.S., Topographical Surveyor, and now Assistant Geologist; and it is upon the plan which he prepared, and which was printed in 1899, that the present geological lines have been laid down.

The tract covered by the plan can best be described as an elevated hilly region surrounded by alluvial plains, which latter gradually fall towards lakes.

The whole was originally thickly covered with mulga scrub with here and there stunted gum trees, but since mining operations started the timber-cutters have made very considerable inroads into it, in fact those portions near the town and mines have been absolutely denuded of timber.

The highest hill is Mt. Misery, 1,660 feet above sea-level, or 330 feet above the alluvial flats; it is situated near the centre of a rough range of hills which run in a north-west direction upon the eastern side of the district. These hills present a steep face to the eastward but are flanked by a belt of broken elevated country to the westward, which gradually descends towards the flats which lie to the north, south, and west.

Except in the hilly regions, well-defined watercourses are of rare occurrence owing to the very gradual fall and the pervious nature of the surface; in consequence, after heavy rain, like thunderstorms, large tracts of the alluvial flats may often be covered for a short time by a thin sheet of water, whilst after light rains no water runs, but the whole becomes so boggy as to be impassable.

Section II.—Water Supply.

Owing to the facts mentioned above and the generally light and very uncertain character of the rainfall this area is not adapted to the conservation of surface water, whilst the subterranean supply is very limited; the area over which that of a potable quality can be obtained is small and the supply extremely limited.

Although the united supply from the above two sources has very frequently proved inadequate for the domestic requirements of the residents the demand for an extra supply is of too intermittent a character to warrant the erection of a condensing plant, there-

fore water is now hauled by the railway from the Goldfields Water Supply reservoir at Kalgoorlie, a distance of 80 miles, which materially increases the cost of living.

In the upper levels of the mines a small supply of salt water is often encountered in sinking but this is practically lost in depth, therefore milling plants, etc., are mainly dependent upon a supply of salt water pumped a considerable distance from a low-lying area to the westward of Menzies, which renders treatment costly and precludes the possibility of the profitable working of low-grade deposits. The underground fresh water supplies are confined mostly to alluvial basins upon the eastern side of the district, and being entirely dependent upon the rainfall the supply varies considerably and is limited.

Annual Rainfall at Menzies.

Year.	Inches.	Days upon which rain fell.
1897	4·52	38
1898	4·45	28
1899	4·86	32
1900	12·17	58
1901	7·17	30
1902	11·26	34
1903	15·24	53
1904	9·70	55
1905	6·81	29

Section III.—Descriptive Geology.

In order to follow this description it will be necessary to refer to the Geological Map of the district, upon which the boundaries of the various formations have been carefully laid down.

By reference to the Explanation of the Colours and Signs upon the map it will be seen that the rocks, which are represented by distinguishing colours and signs, have been classed under the following headings :—1st, the Recent, which is subdivided into Alluvium consisting of clay, loam, sand, and gravel of the flats and creek beds, and Laterites consisting of brown hematite (ironstone), ferruginous claystone, and conglomerate (cement) capping the hills and ridges. 2nd, the Crystalline and Altered Rocks, which have been subdivided into Basic consisting of serpentine and chloritic schists, amphibolites, aphanatic diorite, and other hornblende and allied rocks, and the Acid consisting of sericite, mica schist, granite, and quartzite. 3rd, the Igneous Rocks which occur as dykes of felsite, porphyry, and granite.

Photo., H. P. WOODWARD. Govt. Photo. Litho.

Laterite Hill, near South-West corner of the Water Reserve.

The two general cross-sections at the bottom of the map will make clear the fact that although a very considerable area is mapped as alluvium this is often of little thickness ; in fact near the Lady Shenton mine and at several other points along the auriferous belt it barely covers the weathered schists, whilst reefs often outcrop through it. It is strictly speaking a superficial deposit resulting directly from the weathering of the schists *in situ*, but since it masks the underlying rocks, dykes, etc., and merges imperceptibly into the true alluvium, it has been included under that head.

In both sections the portions of the various rocks near the surface in the zone of hydration have been ruled to indicate their foliated nature, whilst the rocks beneath are coloured to represent diorite and granite respectively as their probable anhydrous character.

Recent Superficial Deposits.

The greater portion of the surface of the area mapped is covered by shallow superficial deposits, which have been classed under two heads, viz.: Alluvium and Laterites.

The Alluvium covers all the plains, flats, and valleys, and consists of soil, clay, loam, sand, gravel, and cement (calcareous conglomerate), varying in thickness from a few inches to many feet, their surface being often covered with fragments of ironstone, quartz, or rock which when auriferous are worked as dryblowing patches and deep leads.

The term alluvium has been adopted to cover these recent surface accumulations as a matter of convenience, but it is hardly accurate nomenclature since only those portions which follow the drainage channels appear to have been deposited by the action of running water, whilst the balance, which is by far the most considerable, has evidently been formed from the gradual disintegration of the rocks by meteoric influences, but for obvious reasons it has been found impossible to distinguish it from the genuine alluvium.

The Laterites are found capping many of the hills and ridges, being apparently the remnants of an extensive formation which covered the entire western portion of the area, the softer portions of which have gradually yielded to atmospheric influences but still leave ample evidence of their previous existence in the ironstone fragments which cover the flats.

These cappings are composed of ironstone, which however varies very greatly in composition from almost pure limonite (hydrated oxide of iron or brown hematite) [1177-8, 1203-4, 6317] to earthy ochres and ferruginous clays.

These ironstones, although presenting a dark chocolate-coloured polished exterior, when broken are found to be of a very porous nature, which renders them very susceptible to atmospheric influences, with the result that the more or less horizontal hard crust has been riddled with pipes and caverns by meteoric water,

which, causing it to collapse from time to time, have so broken these cappings that they mostly present the appearance of an aggregate of rough masses.

Beneath these cappings are soft beds of a more or less earthy nature, which when followed down merge imperceptibly into the oxidised rock beneath; this portion of the formation is also a source of weakness to the ironstone, since animals and reptiles burrowing beneath the harder crust cause falls of the roof through leaving insufficient support.

Laterites are the result of subaerial decomposition of the rocks *in situ*, due to hydration and oxidation in a practically rainless and tropical country, consequently their composition is liable to vary considerably even over a small area, it being governed by the nature of the underlying rocks.

That ferruginous laterite cappings are most commonly met with is due to the fact that the amphibolite series from which they were derived are largely developed upon the goldfields and are rich in iron, whilst further deposits of this nature were able to resist recent denuding influences better than the softer deposits of a purely magnesian, calcareous, and aluminous character, and in consequence they not only remained themselves but also protected the underlying rocks, with the result that they now appear as ridges or hills since the adjoining unprotected country has been denuded. They are of little economic value upon this area, for, with the single exception of that upon the Crusoe hill a small but rich deposit of gold was discovered associated with one of these earthy ferruginous beds; in this deposit the gold was found to be of an entirely different character and of a much higher value than that obtained even from the oxidised zone in the mines, whilst subsequent trenching and cross-cutting beneath it failed to prove the presence of any auriferous body in the vicinity. The inference therefore is that this deposit results from the concentration of gold carried in small quantities in the country rock (this being a common feature of this belt), during which process the silver and baser metals were removed and the fine particles of gold united.

The Crystalline Series.

These rocks not only outcrop over a considerable portion of this area but also underlie directly all the superficial deposits: great interest centres in them as they form the matrix of the auriferous quartz bodies.

They have been divided into two groups upon the map, viz.: (*a*) the Basic, which consists largely of hornblende and minerals resulting from its hydration, such as serpentine, talc, and chlorite; and (*b*) the acid, in which silica predominates.

The basic series are traversed by numerous felsite and granite dykes, which were apparently intruded prior to the formation of the quartz-veins since these latter intersect both the basic and acidic rocks, without the remotest partiality.

Photo., H. P. WOODWARD.

Sericite-schist Outcrop, East of the Emu Lease.

Govt. Photo. Litho.

Of these rocks the basic cover by far the greater extent, presenting generally at the surface a schistose character [750, 752, 754, 1047] merging imperceptibly into massive crystalline amphibolites [801, 1174, 1192, 1988], which usually form rough ridges or bosses, but are clearly not dykes, since all attempts to define their boundaries failed utterly.

When these rocks are sunk upon, as in mining, their character quickly changes, the schistose structure giving place below the water-level (about 100 feet) to a massive aphanitic jointed diorite in which no cleavage planes are visible [6371, 6312, 6331]. It breaks in masses more or less cubical exhibiting absolutely no schistose structure to the naked eye, but on exposure to the action of the weather dormant cleavage planes rapidly develope, when it becomes fissile and splits in a shale-like manner when struck with a hammer. To what depth this dormant fissility actually extends it is impossible in the present condition of our knowledge to determine, but it is known to exist in a slight degree at the greatest depths attained at present in any of the mines, viz., about 800 feet vertical.

The schistosity within this area has a general strike to the north-westward, with an underlay of about 45 degrees to the westward; but in the Kensington belt the direction, for a distance of one mile, is found to have changed to the north-eastward, whilst the dip changes from north-west to south-east.

At the Goodenough, which lies about half a mile to the north of the northern end of the Kensington belt, a sudden change has taken place for a short distance, the cleavage planes striking east and west and dipping south.

The Acid group is only developed at the surface to any extent in one hill mass about two miles in length, which runs in a south-easterly direction from Jowett's Well, situated a little south of Mt. Misery; but they also have been proved to exist in wells and quarries beneath the alluvial flats to the eastward and northward [6339, 6318].

Where these rocks outcrop they generally consist of gneiss, mica schist, sericite schist, and quartzite [6321, 6365, 6320], but these characters are, as in the basic series, lost at a moderate depth below the surface, mica schist giving place to gneiss, and sericite schist to sericite slate; however, it is impossible to study what changes take place in these rocks below the water-level as they have not yet been sunk upon, but to judge from the changes that have taken place in the dyke rocks (as will be gone into later on) it is highly probable that this entire mass is an intrusion of porphyritic granite, altered near the surface by hydration and crushing.

At several points on the alluvial flats to the eastward of Mt. Misery, weathered schists are met with in the wheel-ruts or in trenches, whilst granitic rocks form the country at the Federal Group, which runs in a north-easterly direction, a little to the north-westward of the Kurrajong Lease, 3482. Along the railway line and the Niagara Road granite has been met with in sinking wells,

also in some quarries where weathered granite has been worked a little to the north-eastward of the town.

The basic rocks are intersected by numerous dykes, which are most largely developed at the surface along a belt which extends in a north-westerly direction from the north end of the outcrop of the acid rocks near Jowett's Well, passing the south end of the Kensington belt, and continuing to the northward of the water catchment area, gradually concentrating to the north-east corner of the town by the Hospital Reserve. A few scattered acidic dykes are also visible around Mt. Misery and at one or two other points upon this area; but although they do not outcrop along the auriferous belt owing to the alluvial covering, they are constantly met with in sinking. Such of the dykes as outcrop have been mapped with considerable care, under the supposition that they might have played an important part in the formation and enrichment of the reefs; this, however, upon careful examination of these bodies in the mines situated upon the auriferous belt, proved not to be the case, since it became evident at once that they were intruded prior to the deposition of the quartz veins, which are found to intersect them indiscriminately with the hornblende rocks.

The dykes where they outcrop generally present a felsitic and often silicious appearance, splitting into flags, which have been quarried for pitching purposes upon the northern side of the water reserve [**6367-70**], but at other points they have passed into very friable sericite schists. This latter characteristic is generally met with upon the auriferous belt immediately below the alluvium, but these, like the other rocks, rapidly change in depth.

No examination of these rocks could be made below the surface, except where mining operations have been carried on, but to judge from the general surface character they are apparently of one class, their different nature at the surface being due to local influences whilst metamorphism was taking place.

These dykes, where met with along the auriferous belt, as mentioned above, are generally represented by sericite schist, with here and there small patches of mica representing weathered granite. This character sometimes extends throughout the entire depth of the oxidised zone, or it may pass into weathered gneiss, thence into solid gneiss, or crushed granite, which at greater depths, when struck by bores, proves to be a porphyritic granite with small crystals of black mica [**6340-4, 6337, 6364, 6371**].

A complete series, illustrating this interesting transition from soft-weathered sericite schist into porphyritic granite, have been collected [**6332-6**].

At the north-west corner of this area two dykes of albite granite outcrop, which have been opened up evidently in the hope of their proving auriferous [**6318**].

The basic rocks also contain sparry veins of dolomite below the oxidised zone, whilst above it these are represented by creamy-

Photo., H. P. WOODWARD. Govt. Photo. Litho.

Sericite-schist Outcrop, South of Springfield.

coloured veins of magnesian limestone [6322, 6315-6], which are particularly numerous amongst the serpentine schists. These rocks also contain veins of actinolite and a little inferior asbestos in places [6323, 6325].

Quartz Veins.

The quartz reefs may be first divided into three classes, viz., auriferous, metalliferous, and barren reefs, of which the auriferous may be still further divided into (*a*) fissure veins and (*b*) irregular segregations forming composite lodes, and the barren into (*c*) irregular buck reefs and (*d*) fissure cross-courses.

Large barren buck reefs, which often approach a quartzite in character [785, 1189, 1202], having no definite course and of no considerable length of outcrop, are met with at several points upon this area; they are conspicuous, as they either form bold ridges or fragments and from their disintegration cover considerable areas of the surface.

The cross-courses are barren quartz bodies, formed along fault lines, which intersect the auriferous veins; they have a more or less east and west course and underlay mostly to the north, but are not as a rule of great longitudinal extent.

There are also a series of ferruginous lodes, which at the surface are oxidised, but near and below the water-level they pass into pyrites, mostly marcasite, containing a little gold, which, however, is in too small a quantity to cover the cost of working. These lodes have generally a more or less north-west course, and can often be traced for a considerable distance at the surface. One of these follows the main belt of dykes upon the north-east side, starting from a little east of Merry's Well, passing by the Maranora and Kensington mines to the south westward, and so on in a north-westerly direction for about a mile. Another large lode of this description is met with at the Goodenough mine, but here it does not appear to be of great extent.

Along the auriferous belt, bodies of this description are often met with and are generally known as mineral lodes. They are well-defined and apparently continuous for considerable distances, but are uniformly of very low grade. One very noticeable point with regard to these bodies is that they not only are of little value themselves, but are said as a rule to exercise an impoverishing effect upon the auriferous lodes at any points at which they come in contact.

Composite lodes.—The class of reefs around which the greatest interest centres are those from which the major portion of the gold produced from this district was obtained, and these may be classed as irregular lenticular segregation deposits. They occur either in the form of pipes or a series of lenticular masses; the longest axis, following the cleavage planes of the rock diagonally in a southerly direction, is called the shoot. In the upper levels it is not uncommon to find a series of such veins following parallel planes, but these gradually give out in depth. In the oxidised zone many of

these veins were very rich, the gold sometimes being associated with chloride of silver, whilst below the water-level galena is generally met with if the stone is of high grade. The greatest length to which one of these quartz bodies of the pipe-like form has continued to be payable is that worked in the Queensland Menzies mine; it is about 1,600 feet in length; whilst in the Lady Shenton, where the combined ore shoots have a much greater horizontal breadth, the shoots do not exceed 800 feet in length upon the incline; the vertical depth being in the former 660 feet and in the latter a little over 330 feet. With the exception of the few large mines, these veins are not usually of great extent individually, but more commonly consist of a series of small but rich quartz bodies, forming as a whole a lenticular mass, including the enriched decomposed rock called "formation"; but this latter diminishes the value of the stone too greatly to be profitably worked except by a plant upon the spot, therefore only the quartz is as a rule treated.

Lines of this nature are common throughout this belt, but since the surface is covered by superficial deposits a considerable amount of prospecting is often necessary before they are located. Owing to this, leases are repeatedly abandoned under the supposition that they are worked out, to be taken up later and worked again time after time as further prospecting by other parties revealed the existence of fresh quartz veins. Although other well-defined lenticular quartz bodies may be met with below the point at which the ore-shoot pinched out, it has been found that such bodies, if they do not come into existence either in the oxidised zone or immediately below it, have not been enriched to the extent which renders them payable, whilst the adjoining country rock at many points along this belt has proved to be auriferous.

Fissure-veins are not nearly so common in this district as the segregation veins, but a good example is exhibited in the Consolidated mine, the footwall of which is striated and highly fissile and indurated, indicating considerable movement. The Aspasia lode also shows the same indications. These lodes do not appear to carry so much galena as the segregation veins, neither are they so rich; but this is in a measure compensated for by their greater longitudinal extent of the ore-shoot, and also probable continuity in depth. The pay shoot in these reefs dips in the same direction as the others, viz., in a southerly direction, upon an inclined plane which dips at an angle of about 45 degrees to the south-westward, but they differ in so far that the vein does not of a necessity end at the point where the stone pinches out, but may be met with again further north or south along the fissure.

Faults.

Besides the cross-head joint faults mentioned under cross-courses, which have disturbed the auriferous reefs by throwing them in an easterly or westerly direction, there are a series of faults

Photo., H. P. WOODWARD. Govt. Photo. Litho.

Quartzite Outcrop, half-mile East of Springfield.

and thrust planes which coincide more or less with the foliation of the rocks, and in consequence are not apparent in the oxidised zone. These faults may form the fissures for lodes such as the Consolidated and Aspasia, where they more nearly coincide with the cleavage planes of the rock, or they may occur as thrust planes, when, although generally adopting the universal strike, they cut the foliation planes at a lower angle. These are possibly up-throw faults of limited extent, due to the intense lateral pressure caused by the expansion of the rocks whilst undergoing hydration, in which case they would have existed prior to the formation of the auriferous reefs, which latter sometimes terminate upon them.

PART II.—Economic Geology.

Section I.—General.

In the preparation of this section, which is devoted to a description of the reproductive ore bodies, great difficulties have been experienced owing to the fact that most of the large mines are now inaccessible, whilst, where accessible, timbered levels and worked out stopes (where not mullocked up) afford little information as to the character and size of the lode, since often a considerable quantity of the adjoining enriched rock has been removed with the stone, or the lode may have consisted of a number of small veins which necessitated the removal of the interpolated rock which was crushed or used for filling, according to its value.

To add to this difficulty, little reliable literature exists; whilst plans, in many instances, of underground workings of defunct Companies have been lost or taken away by the owners' representatives, and not lodged with the Government.

Information has therefore been collected from the most reliable sources, such as prospectors, mine managers, etc., who have most kindly done all in their power to assist in the investigations.

In order to give as clear an idea as possible of the nature of the ore deposits and the extent of the work done upon them, working plans, etc., have been reduced and reproduced upon a general map (Plate I.), which will be found of use if followed in conjunction with this section of the report.

The depths of the shafts, etc., have been taken as far as possible from the certified working plans, but, where these were not obtainable, either from official records, information obtained from owner, manager, or personal examination; the latter not being very reliable, since many of the old shafts have been partially filled in or have fallen in. The depths at which water was encountered in sinking, and its character and yield per diem, has necessarily been taken from official and other records, for where shafts have been sunk to a depth below the water-level into the solid country and no further supply is met with, that originally struck often disappears altogether.

The number of tons of stone crushed, with the gold yield therefrom, is taken from the statistics published by the Mines Department, the information being so arranged that no matter how many times a property has changed hands, the total production is given from each individual area.

This area yield must not be confused with the system usually adopted by this Department of adding the totals from an individual reef, no matter how many properties it may pass through, the change of system being found necessary because continuous reefs are almost unknown in this district; in fact, in many instances, the returns from a single property may have been derived from a number of reefs. When tabulated in order to give a grand total, the names of all leases included represent the same area, or portions of it, and not adjoining properties on the same line.

Recently, this field has been worked largely under Protection Areas in place of leases, the yield from which has not been allocated, but is given under the head of various claims in the total.

In the case of mining companies working several leases and giving bulk returns, where possible an analysis has been obtained from the manager in order that the produce may be credited to the particular locality from which it was derived.

There are two auriferous belts within this area; one, which may be called the main or western belt, starts to the north-westward of the town, at the St. Alban's group, from which it runs in a south-easterly direction, widening out as it approaches the town, through which it passes on the western side, then on, gradually contracting until it reaches the township of Yunndaga (Woolgar), south of which it extends two miles, terminating in the Barunga Brave. This belt, like the lodes themselves, is of a lenticular shape, but the resemblance to the individual ore bodies does not end here, for, on investigation, it is found that the belt does not consist of one main defined line, but of a series lying more or less parallel to each other, crossing this main belt diagonally upon a course rather more westerly. These secondary lines are further found to be constituted of lines of disconnected bodies or bunches, and these latter of aggregates of pipes or lenses of quartz.

Parliament of Western Australia. Adelaide: By Authority, 1896, p. 4.

THE HON. H. GREGORY M.L.A.
Minister for Mines

GENERAL PLAN

SHEWING THE PRINCIPAL WORKINGS OF THE

MENZIES GROUP OF MINES

TO ACCOMPANY REPORT ON
THE AURIFEROUS DEPOSITS & MINES OF MENZIES
BY
H. P. WOODWARD
ASSISTANT GOVERNMENT GEOLOGIST
1905

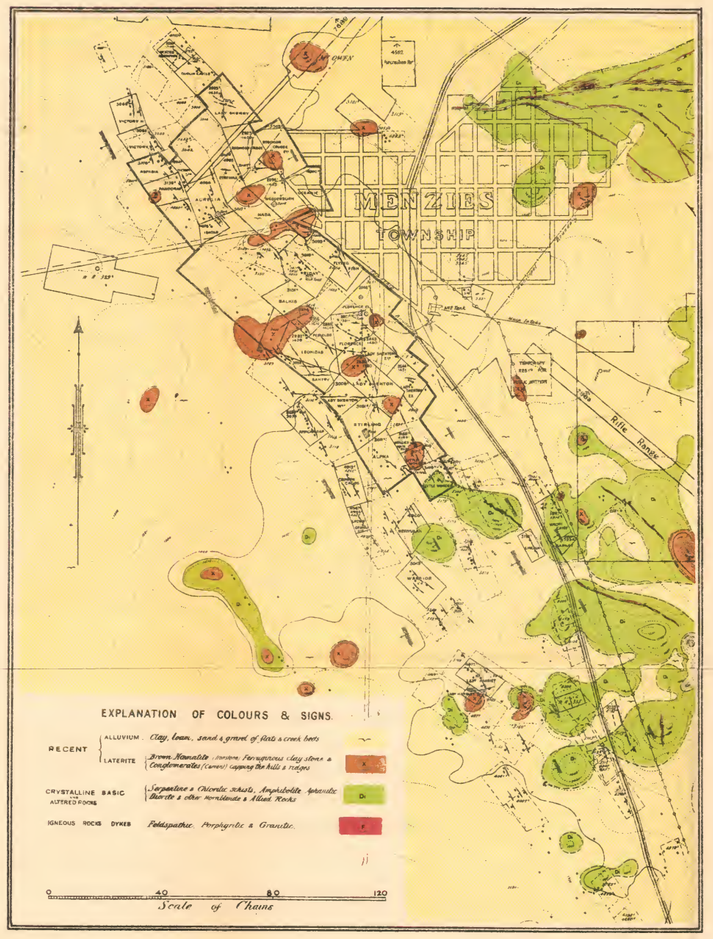
0 6 12 18 24 30
Scale of Chains

EXPLANATION

LEVELS ABOVE 100ft.
" 200
" 300
" 400
" 500
" 600
" 700

LEASES — Name of: STIRLING; Number of: 3031z; Boundaries of; Extinct which have produced Gold. 3149z
SHAFTS
CONTOUR LINES (100 INTERVALS, DATUM SEA LEVEL) 1400 — 1390
Granite Dykes (Approximate)
Depth of Levels 36'L
Crosscuts
Winze & Underlay Shafts
Faults
Dip of Reef
Levels Solid Colour — Crosscuts

LOCALITY PLAN



H. J. Pether, Government Lithographer, Perth, W.A.

The other group, which may be called the Kensington group, strikes in a north-easterly direction upon the western side of Mt. Misery. It is not nearly so long as the main belt, nor has it yielded anything like the quantity of gold. In this group the individual lines are not uniform in their strike and dip, the westward line dipping to the westward, the central lines to the eastward, and the eastern line to the westward, whilst the Kensington at the south, and the Goodenough at the north, strike east and west, dipping south.

Outside these two main belts there are a few scattered leases, but the total yield of the gold from these is inconsiderable.

Section II.—The Ore Deposits and Mines.

St. Alban's Group.—This group of leases, which were originally worked by the Menzies Consolidated Company, is situated upon a low hill of schistose rock that rises above the alluvial flats about three miles north-west of Menzies. Of the St. Alban's lease in 1895, Mr. H. Y. L. Brown, Government Geologist of South Australia, says: "This is a quartz reef which strikes east and west and dips south at an angle of 45 degrees. The gold occurs in quartz."* There are three parallel lines of small reefs, which have been traced for a length of from 50 to 100 feet in an east and west direction in schistose diorite [**805**]. They have been worked by a series of underlay shafts to the water-level, but a vertical shaft has been sunk to a depth of 240 feet, in which a small quantity of salt-water was encountered from 100 to 150 feet. Since the Company abandoned it in 1897 the lease has been continuously worked, but has twice changed hands.

Table showing the Yield of the St. Alban's Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom.	Average rate per ton.
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1898 ...	St. Alban's, G.M.L. 4883z	16·00	66·86	4·18			
1899 ...	Do. ,,	154·75	260·03	1·76			
1900 ...	Do. ,,	94·00	200·15	2·12			
1901 ...	Do. ,,	78·00	131·67	1·69			
1902 ...	Do. ,,	61·00	28·38	·47	403·75	687·09	1·70
1903 ...	Do. 5081z	27·00	20·26	·75			
1904 ...	Do. ,,	31·00	60·78	1·96			
1905 ...	Do. ,,	15·00	23·00	1·87	73·00	109·04	1·49
	Total	...	...	...	476·75	796·13	1·67

* Auriferous Deposits of Western Australia. Adelaide. By Authority, 1896, p. 4.

Resurrection, G.M.L. 4859z.—This lease is situated a few chains to the eastward of the last, the reef, which follows the same course, viz., east and west, has been opened up by a number of shallow underlay shafts upon the dip of the vein, which is to the south in decomposed schistose rock.

Table showing the Yield of the Resurrection Reef.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1897	5·00	5·37	1·07
1898	41·50	17·85	·43
Total	**46·50**	**23·22**	**·50**

The European, G.M.L. 5210z, and **Little Peter,** G.M.L. 5201z, are situated upon a small gravel rise near the Racecourse, about half-way between the St. Alban's and the town. Here some shallow holes have been sunk in the weathered rock, from which on the former 8 tons of stone were raised, which yielded 5·25ozs. of gold, and on the latter 10 tons, which yielded 3·41ozs. About a mile south of the last, at the north of the main belt and upon the north-western side of the town, are two properties now called the **Menzies Proprietary,** G.M.L. 5236z, and the **Dublin Castle,** G.M.L. 5215z, which were originally known as the Little Gem, G.M.L. 3722z, and Selkirk, G.M.L. 2842z, and owned by the Menzies Gold Reefs Proprietary, Ltd., which Company did a considerable amount of prospecting upon them without discovering anything of sufficient size or value to be considered payable. These properties were both taken up by working miners in 1900, and, with the exception of time lost in changing hands, they have been worked ever since.

There are a large number of shallow shafts sunk upon small veins in the oxidised zone, with some driving and crosscutting, the rock being decomposed schist, and the reefs strike upon a north-westerly course and dip to the westward.

Table showing the Yield of the Menzies Proprietary Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom.	Average rate per ton.
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1900 ...	Menzies Proprietary, G.M.L. 4953z	20·00	37·66	1·88			
1901 ...	Do. ...	70·25	53·22	·76			
1902 ...	Do. ...	39·00	71·81	1·84	129·25	163·69	1·25
1903 ...	Menzies Proprietary, G.M.L. 5140z	8·00	16·98	2·12			
1904 ...	Do. ...	183·00	120·11	·65			
1905 ...	Do. ...	10·00	8·63	·86	201·00	145·72	·72
1905 ...	Menzies Proprietary, G.M.L. 5236z	128·00	270·15	2·11	128·00	270·15	2·11
	Total	...	...	...	**458·25**	**588·56**	**1·28**

Table showing the Yield of the Dublin Castle Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom.	Average Rate per ton.
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1900 ...	Dublin Castle, G.M.L. 4952z	38·00	49·36	1·30			
1901 ...	Do. ...	133·00	311·79	2·34			
1902 ...	Do. ...	13·00	37·50	2·88			
1903 ...	Do. ...	72·00	78·37	1·09			
1904 ...	Do. ...	18·00	26·16	1·45	274·00	503·18	1·83
1905 ...	Dublin Castle, G.M.L. 5215z	141·00	230·38	1·63	141·00	230·38	1·63
	Total	...	...	...	415·00	733·56	1·77

A little to the westward of the Dublin Castle are the following old leases, which have been held for short periods only; little work has been done upon them.

Table showing the Yield of the following Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1899 ...	Menzies Main Reef, G.M.L. 4897z ...	39·00	15·98	·42
1903 ...	Easter Gift, G.M.L. 5095z	23·00	5·66	·24
1904 ...	Ophir, G.M.L. 5186z	17·00	5·92	·35
1904 ...	Witch Hazel, G.M.L. 5154z	21·00	8·82	·42
1904 ...	Ada Ella, G.M.L. 5185	10·00	5·53	·55

Victory North, G.M.L. 5068z.—This lease lies to the south of the last-mentioned group and at the extreme north of the Aspasia or western line of lodes. Upon it a small body of stone, about eight inches wide, which follows the usual north-westerly strike and dip of 45 degrees west, has been opened upon at two points upon the eastern boundary. The northern group of workings consist of three shafts, two upon the underlay of the reef, which are connected, and a vertical shaft, which cut the reef at 150 feet, but which has not yet been connected with the other shafts.

Farther south there are two more shafts on the reef, which are connected at a shallow depth.

Table showing the Yield of the Victory North Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1902 ...	Victory North, G.M.L. 5068z	12·00	12·43	1·03
1903 ...	Do. „	51·00	109·83	2·15
1904 ...	Do. „	70·50	91·87	1·58
1905 ...	Do. „	39·00	60·50	1·55
	Total	172·50	274·63	1·59

Victory, G.M.L. 5066z.—This lease, which is situated immediately south of the last, was worked prior to 1901 by the Menzies Mining and Exploration Corporation as the Helena, G.M.L. 3203z, it was then taken up as the Surprise, G.M.L. 5002z, and in 1902 it became the Victory.

A good many shafts were sunk by the original Company in searching for the northern extension of the Aspasia lode, one being 30 feet, with a crosscut 100 feet both east and west in which a number of small veins were met with, whilst on the Surprise a shaft was sunk 43 feet on the western reef with a drive south 35 feet. The deepest shaft is 130 feet, of which 80 feet are vertical, it then follows a small reef with the usual strike but which dips at an angle of 65 degrees west. All the stone raised comes from the oxidised zone, and at the present time all work is confined to a vein upon the eastern boundary.

Table showing the Yield of the Victory Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1901 ...	Surprise, G.M.L. 5002z	65·00	70·51	1·08			
1902 ...	Do. ,,	58·00	45·73	·79	123·00	116·24	·94
1902 ...	Victory, G.M.L. 5066z	20·00	32·52	1·63			
1903 ...	Do. ,,	46·00	194·29	4·22			
1904 ...	Do. ,,	93·00	162·21	1·74			
1905 ...	Do. ,,	80·00	144·61	1·80	239·00	533·63	2·23
	Total	...	...	...	**362·00**	**649·87**	**1·79**

Menzies Lady Sherry, G.M.L. 2835z.—This mine adjoins upon the south of the Dublin Castle and was first worked from 1896 until 1903 by the Menzies Lady Sherry G.M. Company, N.L., who also owned as block claims to the westward, leases Nos. 3806z and 3914z, both of which were named the Lady Sherry West; also 4069z, the lease then called Brown's. In 1903 the property was sold to the present owners, who now only hold G.M.L. 2835z.

Mr. H. Y. L. Brown says of this property in 1895—"Three quartz reefs were being mined upon here at the time of my visit. In No. 1 shaft I observed a quartz reef dipping westerly at an angle of 45 degrees with red mullocky formation, composed of white kaolin and quartz (decomposed granite). No. 2 shaft is on a quartz reef which dips westerly 45 degrees to 60 degrees. No. 3 shaft is also on a quartz reef which branches into veins below. The quartz contains coarse gold. The country rock in the neighbourhood of these mines is argillaceous talcose and chloritic schists and decomposed diorite, and micaceous slate was observed in one place." [**789.**]

This lease has been worked at two points close to the south-west corner, the first being upon a reef which evidently outcropped and was probably the one referred to in Mr. Brown's report as occurring in shafts Nos. 1 and 2.

This reef has been worked to a depth of 107 feet 9 inches by an underlay and vertical shaft; it was not a continuous quartz body, but consisted of broken masses or small lenticular veins. From the bottom level a winze has been sunk 50 feet but no stone was met with. In these workings a faulting cross-course was met with at the bottom of the vertical shaft B, and also in the level at the bottom of the underlay shaft A, its course being a little north of west, with a dip to the northward; it is evidently the same body as is exposed upon the surface to the southward of these workings and between them and the main shaft, having a course nearly east and west. In the other workings, which lie 130 feet to the south-west, a vertical main shaft has been sunk to a depth of 260 feet, a small supply of salt-water being struck at 180 feet. From this shaft a series of small pipe-like lenticular quartz bodies have been worked to a depth of 150 feet, below which no ore has been discovered.

So far as the known ore bodies in this mine are concerned they have no apparent extension downwards below the existing workings, whilst even at the lower levels the veins have either cut out or become exceedingly small and poor; there is, however, a considerable area of untested ground between the existing workings and the Dublin Castle in which other rich veins may exist.

Table showing the Yield of the Lady Sherry Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1897 ...	Menzies Lady Sherry, G.M.L. 3914z	299·00	484·32	1·52			
1898 ...	Do.	449·00	383·20	·85			
1899 ...	Do.	232·00	378·21	1·62			
1900 ...	Do.	131·00	103·36	·78			
1901 ...	Do.	683·00	735·79	1·08			
1902 ...	Do.	414·00	243·08	·58			
1903 ...	Do.	...	13·25	...	2,208·00	2,341·21	1·06
1903 ...	Lady Sherry Leases, G.M.L. 3914z	221·00	286·26	1·29			
1904 ...	Do.	392·25	259·86	·66			
1905 ...	Do.	291·00	198·53	·68	904·25	744·65	·82
	Total	...	...	...	3,112·25	3,085·86	·99

Aspasia and Pandora, G.M.Ls. Nos. 3100z, 3138z.—These leases, which are the property of the Menzies Mining and Exploration Corporation, Ltd., are situated immediately south of the Victory and to the westward of the Lady Sherry, upon them a well-defined reef, which outcrops upon a north-west course with a dip to the south-westward of 53 degrees at the south end and 70 degrees at the north end, has been opened at the surface for a length of 370 feet by a number of underlay shafts. These shafts connect with the No. 1 or 56-feet level, which has been driven for a length of 520 feet, of which 440 feet was in payable stone.

The No. 2, or 117-feet level, has been driven for a distance of 320 feet, the north end to the limit of the pay shoot, whilst the south end was discontinued before that end was reached. The No. 3, or 160-feet level, which is 450 feet in length, has been driven from one end to the other of the ore body, and between it and the surface practically all the ore has been stoped.

A main vertical shaft has been sunk, which has been connected with this level by a crosscut, and also with the No. 4, or 237-feet level, which has been driven for a distance of 300 feet in a well-defined body of stone, that in the south drive, which is 180 feet long, is richer than the northern, but the latter is improving in the face.

From the No. 1 level a crosscut has been driven 100 feet east and 110 feet west, but no other lode of any value was cut.

The outcrop of this lode can be traced throughout the entire length of these two leases, and it is probably the northern extension of one of the reefs worked upon the Aurelia which lies to the southward. The lode is generally rather small in size, varying from 18 inches to 3 feet, but is well defined with a polished and striated footwall, which indicates that it is of the "true or fissure" type, the quartz having been deposited upon the wall of a fault, and in consequence the fissure is probably of considerate extent.

Upon this field veins of this type are not usually so rich as those of the segregation type, but are simpler deposits to handle owing to the fact that, although the quartz may pinch out, the fissure still remains as a guide or leader to further ore bodies. The individual ore chutes are usually of greater length, and so far their limit in depth has not been proved.

Upon this lease a large number of small shafts have been sunk upon small parallel ore bodies, but as yet sufficient work has not been done upon them to determine their character.

In sinking the main shaft, a small supply of salt water was struck at a depth of 144 feet from the surface, but the supply is too small to be of any value.

Since the gold returns from these leases are included in the Company's total, the actual amount yielded has been kindly furnished by the manager.

Total Gold Yield to date.

Ore crushed.	Gold therefrom.	Rate per ton.
tons.	ozs.	ozs.
6,213·00	8,407·00	1·35

The Victory South, G.M.L. 5094z.—This lease is situated immediately to the eastward of the Pandora, and upon it a

small shoot of stone has been followed down into the last-mentioned lease.

Table showing the Yield from the Victory South Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1904 ...	Victory South, G.M.L. 5094z	243·00	166·50	·68
1905 ...	Do. „	44·00	145·31	3·30
	Total	**287·00**	**311·81**	**1·08**

The Etrenna and Aurelia, G.M.Ls. 4965z and 4966z.—These leases are a portion of what was originally the Menzies Gold Estates, Ltd., which Company worked them up to the year 1899. In 1900 and 1901 the returns are given under the title of Etrenna and Aurelia leases, after which date they became the property of the Menzies Mining and Exploration Corporation, Ltd., and in consequence the returns have been bulked, but the manager has kindly supplied the figures with regard to the leases.

The Etrenna lease is a portion of what was originally the Crusoe West, G.M.L. 3054z, and upon it a vertical working shaft has been sunk to a depth of 600 feet in extremely hard aphanitic diorite [**6331**], with the object of cutting the dip of the Crusoe reefs at 504 feet and 624 feet. As, however, no lode indications were met with, this work was abandoned (Plate II.). Later developments in the Crusoe prove that the vein did not extend into this lease. Upon the Aurelia, which was formerly called Wilson's, G.M.L. 3046z, three parallel lines of reefs have been worked to a vertical depth of from 80 to 110 feet, below which they decrease both in size and value. The eastern reef has apparently a very long outcrop, and if the working upon the Ishtar, G.M.L. 4976z, which lies to the south, are upon the same line, it gives a total length of 800 feet. The outcrop of this reef has been opened upon on this lease for a length of 450 feet, and driven on at the 63-feet level for a distance of 200 feet, and at the 95-feet level for 90-feet. It is a well-defined reef but of low value, 15dwts. being about the highest, the gold being worth little over £3 10s. per ounce.

The central reef has been driven on at the 56-feet level for a distance of 350 feet, and at the 87-feet level for 30 feet, the ore chute giving out at the bottom.

The western reef has been worked for a length of 350 feet at the 65-feet level and for 160 at the 112-feet level, beneath which the stone was valueless.

These reefs have only been worked in the oxidised zone, but, so far as can be judged, they are of the fissure type. If this should prove to be the case they would be worthy of further development in order to prove whether or not the veins increase in size and value

in the solid country, as 110 feet vertical depth is no criterion as to what these lodes may possibly be at a depth.

Table showing the Yield of the Aurelia Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1897 ...	Menzies Gold Estates, Ltd., G.M.Ls. 3042z, 3046z, and 3054z	400·00	131·22	·33			
1898 ...	Do. ...	31·00	18·68	·60	431·00	149·90	·35
1899 ...	Do. ...	...	...	...	...	...	...
1900 ...	Etrenna and Aurelia, G.M.Ls. 4965z and 4966z	123·25	110·07	·89			
1901 ...	Do. ...	101·00	111·17	1·10	224·25	221·24	·98
1902-5	Menzies Mining and Exploration Corporation, G.M.L. 4966z	687·75	618·46				
	Total	...	...	...	1,334·00	989·60	·74

The Ishtar, G.M.L. 4976z, is a portion of what was originally one of the Crusoe block claims, No. 3148z, and if it yielded any gold under former ownership, the record has been bulked and lost. The lease is now the property of the Menzies Mining and Exploration Corporation, Ltd., whose crushing returns are furnished by the manager. Seven shafts have been sunk upon what appears to be the continuation to the southward of the Aurelia reef, but although about 500 feet of driving has been done, no payable lode has been cut.

The Aurelia West, G.M.L. 5011z, is the property of the Menzies Mining and Exploration Corporation, Ltd., and is situated immediately to the westward of the Aurelia.

A shaft has been sunk to a depth of 76 feet, and a crosscut driven 200 feet east and west; in this latter a small vein of stone was cut 30 feet west of the shaft, from which a crushing was taken; at the west end, 90 feet from the shaft, an altered dyke was passed through. Fifty-six tons of stone crushed from this lease yielded 86·95ozs. of fine gold.

The Maori, G.M.L. 5196z., is situated within the township boundaries at the northern side, and covered a portion of the Government Reserve, upon which are the Warden's Court and Police Station.

These leases were originally held by the Maori Gold Mines, Ltd., in 1896 and 1897, which Company had one of the first batteries at work upon the field. All the developments were confined to one lease, No. 3059z, the principal portion of which was re-pegged

in 1898 and taken up as the Union Jack, G.M.L. 4889z; in 1901 it changed hands, and became the **Maori,** G.M.L. 4983z; whilst in 1904, with the name retained, it became G.M.L. 5196z.

A considerable amount of work has been done, but the only information obtainable was that a vertical shaft had been sunk to a depth of 280 feet without striking water.

Table showing the Yield of the Maori Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom.	Average rate per ton.
		tons	ozs.	ozs.	tons	ozs.	ozs.
1896 ...	Maori G M., Ltd , G.M.L. 3059z	496·00	560·50	1·13			
1897 ...	Do. ...	75·00	93·56	1·04	571·00	654·06	1·11
1898 ...	Union Jack, G.M.L. 4889z	80·00	107·07	1·33			
1899 ...	Do. ,,	281·00	351·24	1·23			
1900 ...	Do. ,,	232·00	220·79	·95	593·00	679·10	1·16
1901 ...	Maori, G.M.L. 4983z ...	64·00	29·45	·46			
1902 ...	Do ,, ...	...	51·27	...	64·00	80·72	1·26
1903 ...	Do. ,, ..						
1904 ...	Do. 5196z ...	12·00	2·63	·22	12·00	2·63	·22
	Total	...	...	...	1,240·00	1,416·51	1·14

The Freeman, G.M.L. 5039z, is a portion of the original Maori, and lies immediately south of the main workings upon what is now the Railway Reserve, therefore all the old shafts have been filled in. From this lease 3,000 tons of stone were crushed which yielded 20·75ozs. of fine gold.

The Menzies United was the name by which G.M.L. 3345z situated within and upon the south side of the town, was known. In 1902 it was taken up as the **Horseshoe,** G.M.L. 5045z, and in 1904 as the **Menzies Horseshoe,** G.M.L. 5145z; it is now abandoned.

Table showing the Yield of the Horseshoe Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom.	Average rate per ton.
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1898 ...	Menzies United, G.M.L. 3345z	12·00	3·21	·26	...	...	...
1899 ...	Do. ...	127·00	92·88	·73	139·00	96·09	·69
1902 ...	Horseshoe, G.M.L. 5045z	43·00	13·74	·31	43·00	13·74	·31
1904 ...	Menzies Horseshoe, G.M.L. 5145z	62·50	19·02	·30	62·00	19·02	·30
	Total	...	...	...	244·00	128·85	·52

The Crusoe Gold Claims, Ltd., own four leases, viz., Robinson Crusoe, G.M.L. 2823z; Robinson Crusoe East, G.M.L. 3009z; Naida, G.M.L. 5017z; and Friday, G.M.L. 5018z. As now constituted, it is an amalgamation of the Menzies Crusoe Gold Claims, Ltd., and the Menzies Gold Reefs Proprietary, Ltd.

The Crusoe mine is situated upon lease 2,623z., and consists, roughly, of three groups of workings, besides a large quarry from which a considerable quantity of auriferous gravel was raised, in the laterite capped hill upon which the battery stands. The three groups of workings may be classed as follows:—First, the extension and dislocated extension of the Queensland Menzies lode, which outcrops at the south-west corner of lease 3009z, and underlays into the south-east corner of 2823z and the Queensland Menzies; second, the central group which is situated about midway between the other two groups at the centre of the southern portion of lease 2823z; third, the main group lies in the centre and extends towards the north-east corner of the same lease.

In 1895, Mr. H. Y. L. Brown says: "The lode formation in this mine is a quartz reef associated with quartz and ironstone veins in a white kaolin rock apparently a decomposed felsite. This is of considerable width in places, but irregularly defined. Rich specimens of gold are found in the formation generally." *

First. A considerable amount of work has been done upon the outcrop of the Queensland Menzies shoot, but the line of reef has apparently been dislocated by cross courses. A deep shaft was sunk and a considerable amont of crosscutting done to the northward of this break, but no indications of the continuation of the reef could be obtained. No. 3 shaft is an underlay in the corner of lease 3009z, and appears to have been sunk on a portion of the Queensland Menzies outcrop, which was worked to a depth of 72 feet; all the other workings in this locality are inaccessible and there are apparently no plans other than of No. 3 shaft.

Second. Here three shafts have been sunk upon a reef which runs in a north-westerly direction, and dip to the south-west. From the northern shaft B, a winze has been carried down 155 feet upon a pipe of ore which dips south. A cross vein which strikes east and west and underlays north passes through these workings, which are not now accessible.

The main workings (Plate II.) lie about 270 feet to the north-west of the last; the reef, which has a course of from north to a little east of north, has been worked by a main vertical shaft 340 feet in depth and a series of underlay shafts and winzes.

There were three shoots of ore in this mine; the first or northern shoot was small and only about 40 feet in width, cutting

* *Loc. cit.*, p. 4.

EEF

R. H. Irwin del.

H. J. Pether. Government Lithographer. Perth. W. A.

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

Hon. H. Gregory M.L.A.
Minister for Mines.

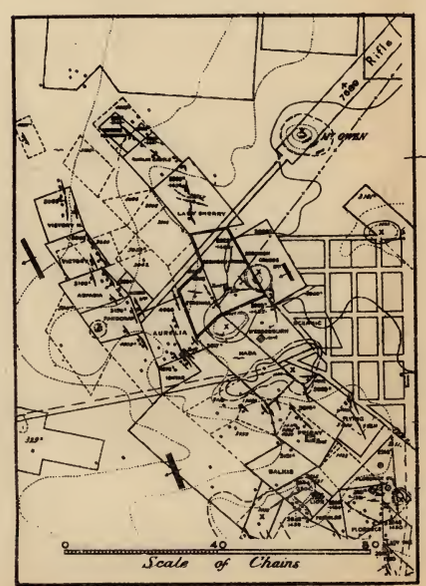
SECTIONS OF THE CRUSOE REEF

CRUSOE GOLD CLAIMS LTD

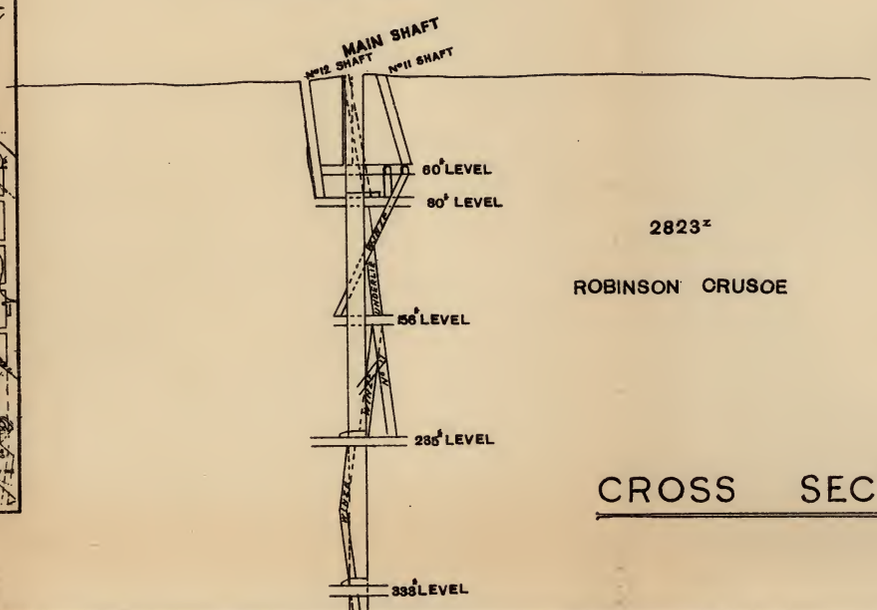
N. COOLGARDIE G. F.

0 100 200 300

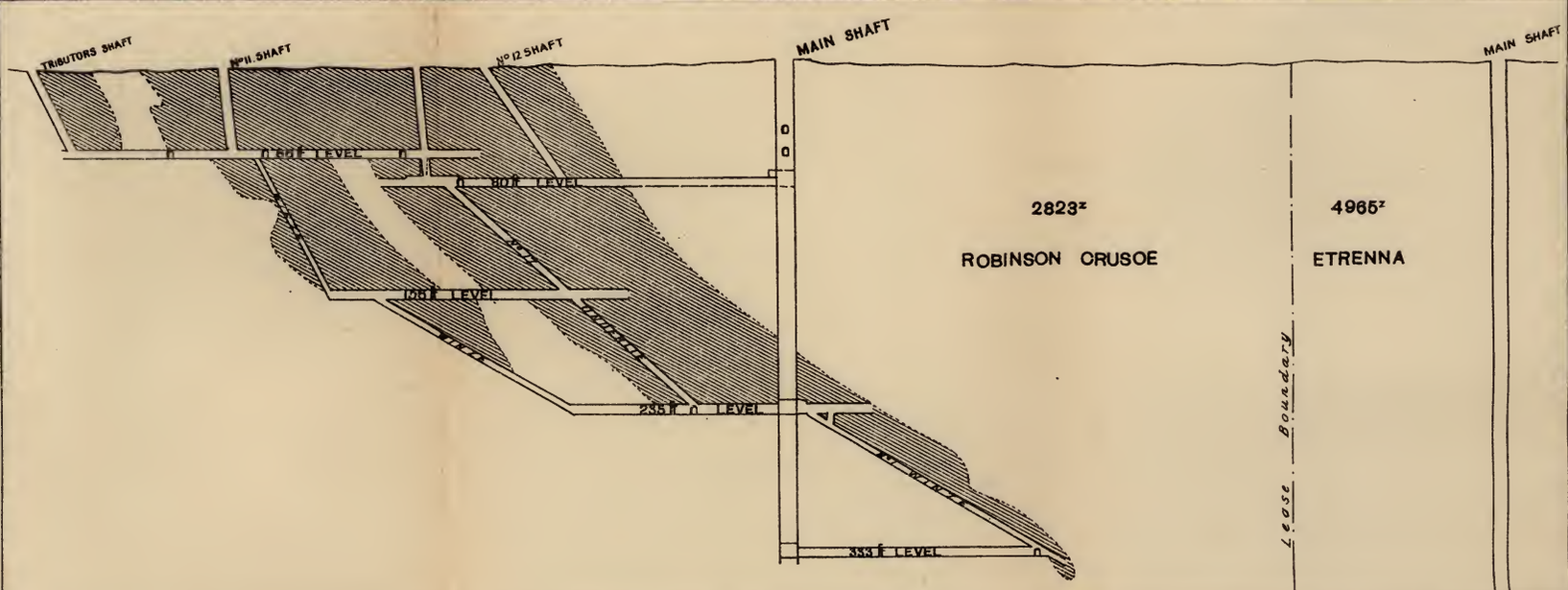
Scale of Chains



LOCALITY PLAN



CROSS SECTION



LONGITUDINAL SECTION

NOTE — Stoped .....

A. Gibb Maitland
Government Geologist.

R. H. Irwin del.

H. J. Pether, Government Lithographer, Perth, W.A.

out at the 60 feet level. The second and third shoots were worked as one continuous ore body of 280 feet in length from the surface down to the 60 feet level, below which, however, the northern portion pipes off decreasing in size to 80 feet at the 156 feet level, and dying out about half-way between this level and the 235 feet level. The southern shoot which was the largest and longest in the mine was 170 feet wide at the 80 feet level, 130 feet at the 235 feet level, but below this it suddenly closed in to 50 feet in width, which gradually diminished until it died out altogether, a little below the 333 feet level. The sudden decrease in size is apparently due to the fact that a thrust plane makes its appearance coming in diagonally from the footwall, this may, if the dislocation took place after the formation of the reef, have severed a portion of the shoot below the 235 feet level. Indications rather point, however, to the prior existence of this thrust plane, in which case the reef fissure will be found to terminate upon it; this question could have readily been determined by an examination of the quartz at its contact with the fault at the time the stone was being worked.

The quartz veins in this mine have no polished walls or casing, the stone adhering firmly to the rock in the hard ground, whilst no line of fissure is met with after the stone has ceased to exist, therefore clearly pointing to their origin by segregation, and not by the upflow of magmatic solutions. That no continuation of the ore channel exists in depth has been clearly proved in the adjoining property, where the Menzies Gold Estates, Ltd., sunk a deep shaft with the object of cutting this lode. Nothing, however, but very solid rock was met with. There is no water in these workings, whilst the country is fairly soft to the 235 feet level [**6322, 6323, 6325**, and **6326**].

To the northward of these workings a small quartz body, with a north-easterly course, has been worked to a depth of 144 feet, but it has apparently no continuity.

Whilst doing some work in connection with the battery, which is situated upon a low ironstone hill at the south-east corner of the lease, a deposit of auriferous gravel was met with, the gold in which was of a much higher value than that obtained from the reefs. A number of small shafts were sunk, and a considerable amount of crosscutting and trenching done with the object of locating the source from which this gold was derived. Since, however, no reef or leader was met with it is evident that this deposit is merely a surface accumulation resulting directly from the weathering of the rocks themselves, which often carry gold in small quantities along this belt.

All the known ore-shoots upon this mine are practically worked out, but as there is a considerable area of ground still unprospected other veins may yet be discovered upon the property, whilst cross-cutting below the 235 level may possibly reveal a dislocation of a portion of the main ore-shoot.

Table showing the Yield of the Crusoe Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom.	Average rate per ton.
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1896 ...	Menzies Crusoe Gold Claims. Ltd., G.M.L. 2823z	3,244·00	6,226·42	1 91			
1897 ...	Do.	4,199·00	5,631·23	1·34			
1898 ...	Do.	2,287·00	3,744·09	1·64			
1899 ...	Do.	6,077·00	6,399·21	1·05			
1900 ...	Do.	946·00	611·72	0·64			
1901 ...	Do.	1,726·00	1,319·58	0·65	18,479·00	23,932·25	1·24
1902 ...	Crusoe Gold Claims, Ltd., G.M.L. 2823z	675·00	720·30	1·07			
1903 ...	Do.	1,562·00	1,005·79	0 64			
1904 ...	Do.	6,005·00	2,818·84	0 47			
1905 ...	Do.	3,533·00	1,417·93	0·40	11,775·00	5,962·86	0·50
	Total	...	...	...	**30,254·00**	**29,895·11**	**0·99**

Queensland Menzies Gold Mining Co., N.L.—This Company's property consisting of two leases, the Wedderburn, G.M.L. 2836z, and the Oceanic, G.M.L. 4969z, is situated upon the main auriferous belt, the Oceanic being within the town of Menzies, and the Wedderburn immediately west of it and south of the Crusoe.

The Queensland Menzies mine is upon the Wedderburn lease, whilst the Oceanic, from which a small amount of gold was previously obtained, was taken up as a block claim in 1891, since which time very little work was done until recently, when a long crosscut was started with the object of testing the lease for lodes.

The Wedderburn was taken up in 1895, in which year Mr. H. Y. L. Brown says of it in his report:—"This is a quartz reef in which coarse gold is visible, striking N.N.W." * It has been continuously worked ever since, and has been one of the most profitable mines in the Menzies district.

The outcrop of the reef was discovered at the north-east corner of the lease, and was traced in the south-west corner of the Crusoe, G.M.L. 3009z, the entire length being something like 500 feet.

The developments upon this mine, until quite recently, consisted entirely of working shafts, levels, and winzes in the ore body, and crosscuts from the shafts to the levels; when, however, the vein gave signs of pinching out, at the instance of Dr. Jack, who was called in to advise the owners, a certain amount of prospective driving and crosscutting was undertaken.

A main vertical working shaft has been sunk to a depth of 549 feet, and an old main shaft 240 feet, an old water shaft 175 feet, and an underlay shaft 80 feet (Plate III.). Eight levels have been driven at 60 feet, 90 feet, 183 feet, 230 feet, 300 feet, 366 feet, 446 feet, and 534 feet respectively, vertical depth from the surface,

* *Loc. cit.*, p. 4.

S

e Hon: H. Gregory. M.L.A.
Minister for Mines.

DINAL SECTION

OF THE

URN G.M.L 2836z REGd Nº 1435 POST „

ND MENZIES G.M.Cº

OOLGARDIE G.F.

Scale of Feet

100 200

— *Stoped*.....

Boundary

The Hon: H. Gregory M.L.A.
Minister for Mines.

LONGITUDINAL SECTION
OF THE
WEDDERBURN G.M.L
2836 REGT Nº
1435 POST „
QUEENSLAND MENZIES G.M.Cº
N. COOLGARDIE G.F.

Scale of Feet
0 100 200

Note — Stoped

LOCALITY MAP

A. Bill Maitland
Government Geologist.

C.B. Kirkton
16 3 06

H.J. Pether, Government Lithographer, Perth, W.A.

the total length of which, inclusive of crosscuts, is about 3,000 feet. From a crosscut at the No. 8 level the lode has been followed down for a further distance of 210 feet on the dip to near the boundary of the adjoining property, the bottom of which is 617 feet vertical depth below the surface.

A small supply of salt water averaging about 100 gallons a day was cut at 150 feet below the surface beneath which a zone of about 50 feet of saturation was passed through, then hard impervious rocks were encountered.

The rocks which enclose the ore bodies may be divided into three zones, first, from the surface downwards about 100 feet may be called the oxidised zone in which the rocks gradually pass from yellow greasy clays into weathered schists of an argillaceous and chloritic nature; in the second, which may be called the zone of hydration, rocks of a more compact nature are met with, such as serpentine and hornblende schists; whilst in the third, or sulphide zone, which starts below the water-charged rocks an extremely hard aphanitic diorite is encountered, this rock, although presenting no foliation, has a distinct cleavage which is identical with the foliation of the schists; this although not always apparent very quickly develops upon exposure to the atmosphere, whilst the dormant and accompanying cross heads are taken advantage of in breaking ground [**6311, 6312,** and **6324**].

The schists have a defined and very uniform foliation, the planes striking 20 degrees west of north and underlaying at an angle of about 45 degrees to the south-westward, whilst the ore chutes lie upon and cross these planes diagonally dipping at an angle of 35 degrees on a course of 15 degrees west of south.

The ore body in this mine although presenting the appearance of one continuous lode in the oxidised zone composed of quartz and formation on approaching the more solid country rapidly formed into a number of pipe like veins, the largest of which received distinctive names such as the western, eastern and hanging wall veins. The breadth of these combined ore bodies decreases rapidly with depth, starting with 500 feet (inclusive of the Crusoe) near the surface they become reduced to 150 feet at the 446 feet level, whilst the total width at the bottom of the winze, the lowest portion of the mine, does not exceed 20 feet. This is not only due to the diminution in size of the individual veins, but more particularly to the fact that they gradually die out one after the other until at the bottom only one remains and that very emaciated.

The ore-shoot in this mine has an exceptional length for a vein of this character in this district, it being 1,125 feet on the dip from the surface to the present bottom.

The individual quartz bodies vary very greatly in size, being of a lenticular pipe-like form; they start from nothing, gradually expanding until their maximum thickness, which may be many feet, is attained, then gradually diminish again. In consequence, it is

impossible to state what is the average size of the stone, but if the area of the stoped ground is taken, and the stone crushed cubed back into the solid, it gives an average of something like two feet of stone, which has averaged over $1\frac{1}{2}$ozs. of fine gold per ton.

These veins have no walls, in the accepted mining sense, the quartz being attached to the enclosing rock, whilst small strings of quartz often penetrate it for a considerable distance. The solid diorite rock in the immediate vicinity of the veins often carries gold in appreciable quantities, specimens having occasionally been met with in which coarse particles of gold were visible without the aid of a glass.

The enclosing fissures present all the appearance of shrinkage contortion cracks, having no continuity in depth nor length, and, although a number of them may occur in a group, or even upon the same planes of foliation, no connection whatever exists between them; they are therefore clearly segregation veins, the mineral matter, including the gold, having been infilled by percolation, either vertical, lateral, or both.

The group of veins worked in this mine lie at a point where a slight change in the course of the foliation has taken place; therefore the formation of the fissures may be due to the crumpling or buckling of the rocks after the release by thrusts of the lateral pressure, which caused their elongation or stretching. The quartz in the sulphide zone is often heavily charged with galena and iron pyrites, the former being a sure indication of the presence of gold. To the eastward or upon the footwall side of the ore body, a belt of indurated and highly fissile schist is encountered at several points in this mine, where cross-cutting has been done in that direction; this is clearly a thrust plane and is said to cause a fall in the ore values when it approaches the lode.

Upon the western side or hanging wall, a large well-defined quartz body, very heavily charged with pyrites, called the mineral lode, has been cut at several points, but this body carries very little gold.

Driving in this mine along the course of the lode has failed so far to disclose any other ore bodies, but in order to make this prospecting thorough, the country should be cross-cut, at intervals of at least every 50 feet to the schist on the one side and the mineral lode on the other; should this fail to disclose the presence of other chutes, it may be assumed that the veins in this mine do not extend north and south beyond the buckled area referred to above, in which, however, there is still the chance of other veins being picked up, and this point should be determined before any further exploration is undertaken.

Since these veins are apparently filled by percolation and have proved to be more numerous, of greater size and richness in the upper levels, prospecting in that portion of the mine would offer greater possibilities than the lower levels, but at the same time veins cut in the latter are almost certain to extend into the former, but on

the other hand those met with in the former may or may not extend into the latter. This lode on the whole has been free from trouble, the first fault being met with near the bottom of the mine; this threw the reef several feet to the eastward, but upon a second fault being encountered further work was abandoned since the stone was not only small and of little value but there was no great distance to drive to the boundary of this property.

Table showing the Yield of the Queensland Menzies Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1896 ...	Wedderburn, G.M.L. 2836z	41·00	251·78	6·14
1897 ...	Do. „	4,031·00	12,856·03	3·19
1898 ...	Do. „	2,429·00	6,894·27	2·83
1899 ...	Do. „	3,500·00	7,801·38	2·25
1900 ...	Do. „	3,143·00	6,113·98	1·94
1901 ...	Do. „	2,962·00	6,621·63	2·57
1902 ...	Do. „	5,155·00	8,124·33	1·57
1903 ...	Do. „	7,249·00	10,029·75	1·38
1904 ...	Do. „	9,973·00	6,874·46	·69
1905 ...	Do. „	6,368·00	8,241·21	1·29
	Total	**44,851·00**	**73,808·82**	**1·64**

The Oceanic, G.M.L. 4969z, adjoins the Wedderburn upon the east, and covers a portion of the township. It is now the property of the Queensland Menzies Co., but was worked as G.M.L. 4920z in 1899, when 101·00 tons of stone were crushed, yielding 62·13 ozs. of gold. Since then the Company has crushed 50·00 tons, which yielded 26·52 ozs. of gold.

The Menzies Gold Reefs Proprietary, Ltd., which has now amalgamated with the Menzies Crusoe Gold Claims, Ltd., under the title of the Crusoe Gold Claims, Ltd., originally owned a large number of leases, situated at different parts of this district, but finally abandoned all with the exception of the Friday G.M.L. 2825z and Naida G.M.L. 3016z, and it was upon the former of these that all the work was concentrated in what was known as the Friday mine.

This mine is situated to the southward of the Queensland Menzies, and to the westward of the town, at about the centre of the main auriferous belt. It was taken up in the year 1895, and was shortly after inspected by Mr. H. Y. L. Brown, who says:— "This possesses a well-defined quartz reef, having a strike north-west and northerly, and dipping south-west at an angle of about 40 degrees. The veinstone consists of bluish, laminated, and veined quartz, containing galena, pyrites, and coarse gold." *

* *Loc. cit.*, p. 4.

This mine has now been completely closed down for some years; the following information is, therefore, taken entirely from the working plans, records, and information obtained from reliable sources (Plate IV.).

There are three main levels in this mine: No. 1, or 80-feet, is 350 feet long; No. 2, or 150-feet level, is 450 feet long; No. 3, or 200-feet level, is 500 feet long; whilst from the No. 3 level a winze has been sunk to a depth of 100 feet upon the underlay of the lode, and from it a level has been driven for a distance of 70 feet at a vertical depth of 240 feet, or 30 feet from the bottom of the winze. In the Menzies United, Ltd., property, which adjoins this lease to the south, the continuation of this lode was cut, and proved to be of no value, and died out at the 388-feet level.

Two underlay shafts connect the No. 1 level with the surface, whilst a main vertical shaft has been sunk to the 200-feet level. A crosscut has been driven from the 150-feet level 180 feet east, where a mineral lode was cut, which is evidently the same reef as outcrops at the surface, near the eastern boundary.

Judging from the plan a defined ore-shoot with a southerly dip was worked down to the 200-feet level beneath which it tapered off into a pipe, becoming small and low in value, until work was abandoned before the boundary was reached. This ore body dipped at an angle of 53 degrees at the north end but flattened to 40 degrees towards the south; the thickness of the stone is said to have ranged from three to 18 inches.

Good stock water was struck at a depth of 129 feet, the daily yield being estimated at 500 gallons.

This reef was evidently of the lenticular fissure type, and probably consisted of a series of pipes, which become more or less united in the upper levels; the southernmost one, as is generally the case, extended to a greater depth than the others. The continuation of this shoot was cut in the Menzies United, Ltd., lease Balkis; which adjoins and will be mentioned later.

With the exception of the crosscut east to the mineral lode mentioned above, little prospecting has been done to prove to prove the existence of other lodes, whilst upon the Naida, which adjoins to the north, and upon which the battery is located, absolutely no work has been done.

Since these leases (the Friday and Naida, which are now held) are situated in the very heart of the auriferous belt, it is very probable that other reefs may exist beneath the alluvial covering; this could be determined by trenching and crosscutting for a fairly moderate cost.

It was mentioned previously that the Queensland Menzies shoot was lost on a fault near its boundary; had this continued it would have extended into the Naida, which adjoins it to the westward. Judging, however, from the character of the vein at the bottom of

BULLETIN Nº22 PLATE IV.

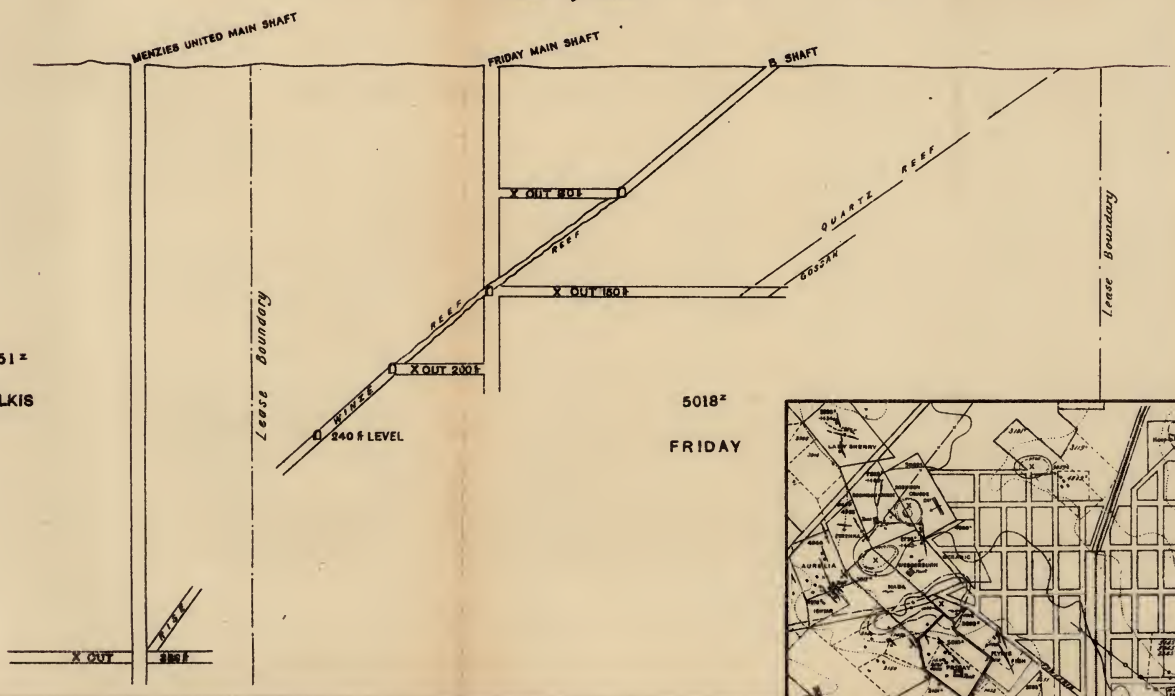
GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
Hon. H. Gregory M.L.A. Minister for Mines.

SECTIONS OF THE FRIDAY REEF

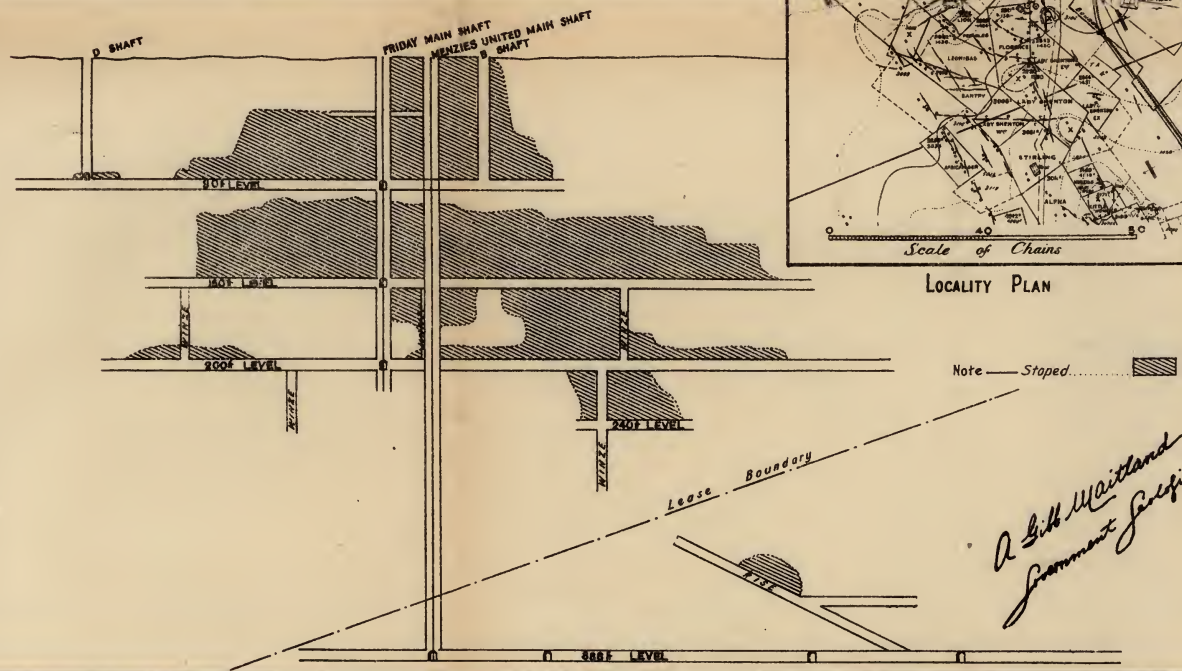
CRUSOE GOLD CLAIMS Ltd

N. COOLGARDIE G.F.

0 100' 200' 300' 400'
Scale of Feet.



LOCALITY PLAN



Note —— Stoped.....

A. Gibb Maitland
Government Geologist.

H. J. Pether, Government Lithographer, Perth, W. A.

the mine, there is little prospect of stone of any value continuing, although a small pipe of quartz may do so.

Table showing the Yield of the Friday Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1896 ...	Friday G.M.L. 2825z ...	2,272·00	2,936·47	1·25			
1897 ..	Do. ,, ...	2,531·00	2,640·21	1·04			
1898 ..	Do. ,, ...	501·00	3,234·25	6·45			
1899 ..	Do. ,, ...	667·00	991·16	1·48	5,971 00	9,802·09	1·64
1900 ..	Do. 4939z ...	37·00	877·86	23·72			
1901 ...	Do. ,, ...	16·00	36·16	2·26			
1902 ..	Do. ,, ...	...	465·26	...	53·00	1,379·28	26·02
1902 ..	Do. 5018z		94·51				
1903 ..	Do. ,, ...	39·00	17·71	·45	39·00	112·22	2·87
1904 ...	Do. ,, ..						
1905 ...	Do. ,, ...						
	Total	...	...	...	6.0 3·00	11 293·59	1·86

The Menzies United Mines, Ltd.—This Company owned a group of leases to the westward of the Friday, upon one of which, called Balkis, G.M.L. 3151z, a deep shaft was sunk with the object of cutting the underlay of the Friday load. The position chosen for this shaft was unfortunate, owing to the fact that no allowance was made for the southerly pitch of the ore-shoot (which at the time was probably not demonstrated); this necessitated extension driving through barren ground in a southerly direction in order to pick it up, this work being of absolutely no value from an exploratory point of view.

At a vertical depth of 388 feet, a level was driven south from the main shaft for a distance of 330 feet, when it encountered a small vein which split into two to the southward. (Plate IV.)

At the junction of the two veins a rise was carried up on this small ore body towards the Friday boundary, and a small intermediate level driven south 65 feet. A small parcel of stone was crushed from this rise and level but the vein was too small to be remunerative. Two crosscuts were driven, one east and one west, from the 388-feet level to the northward of the ore-shoot in which nothing was cut resembling a formation.

At a depth of 150 feet stock water was cut, which yielded a supply of about 400 gallons per diem.

Upon the leases owned by this Company a total of about 2,000 feet of sinking and 2,500 feet of driving has been done without result.

The Balkis is at present held by the Menzies Mining and Exploration Corporation, Ltd., which Company has failed to prove the lease of any value, whilst the others have been pretty well prospected since their abandonment without result.

From this lease 132 tons of stone have been crushed, which yielded 138ozs. of fine gold.

The Central Menzies Gold Mines, Ltd.—This Company also owned a lease called the Emulator, G.M.L. 2834z, which lies to the north of the Friday, upon which 484 feet of sinking and 790 feet of crosscutting was done with the object of cutting the northern extension of that reef. All this work, however, proved to be valueless.

The only crushing from this lease was in 1900, when 19·00 tons were treated, and yielded 18·15ozs. of gold.

The Menzies, Ltd.—This was another of the old Exploration Company's, that held a number of leases, consisting of the Lady Shenton North, G.M.L. 2826z, Florence North, G.M.L. 2828z, Pericles, G.M.L. 2829z, Shirkin, G.M.L. 3050z., Fennine, G.M.L. 3051z, Bantry, G.M.L. 3055z, and Stuart, G.M.L. 3056z. Upon these leases, with the exception of the Shirkin, of which lease no plans exist, 700 feet of sinking and 1,360 feet of driving was done, the only reproductive work being upon the Shenton North, where the outcrop of a lode was worked which dips into the Leonidas.

This Company appears to have abandoned these leases in 1901, when they were retaken by the various Companies and parties of working miners.

Flying Fish Leases.—These leases are situated upon a portion of what was originally the Shirkin, which lies upon the south-west side of the town, and to the north-east of the Friday. They have been worked continuously since 1901 upon some small but rich quartz veins of the usual segregation type in the oxidised zone.

Table showing the Yield of the Flying Fish Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		tons	ozs.	ozs.	tons	ozs.	ozs.
1901 ..	Flying Fish G.M.Ls. 4982z, 4991z	56·00	98·19	1·21			
1902 ...	Do. ...	107·70	472·78	4·39			
1903 ...	Do. ...	46·00	159·69	3·47	209·50	730·66	3·48
1903 ...	Flying Fish G.M.L. 5089z	180·00	548·16	3·04			
1904 ...	Do. ,,	215·00	447·58	2·08			
1905 ...	Do. ,,	304·00	265·58	·87	699·00	1,261·32	1·80
	Total	...	...	...	**908·50**	**1,991·98**	**2·19**

The Lady Shenton North.—This lease, as stated above, was worked by the Menzies, Ltd., from 1898 to 1900, after which it was abandoned, since which it has been taken many times in varying forms by working miners, who have pretty well riddled the ground from the old workings to the surfaces of a lode which outcrops upon it, but underlies into, and has been worked upon, the Leonidas, the adjoining lease to the westward [**756.**]

Table showing the Yield of the Lion Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1898	Lady Shenton North G.M.L. 28?6z	69·00	194·28	2·81			
1899	Do. ...	116·00	220·85	1·19			
1900	Do. ...	53·00	42·15	0·79	303·00	457·23	1·49
1901	Success G.M.L. 498?z ...	110·00	78·77	0·71			
1902	Do. ...	10·00	35·32	3·53	120·00	114·09	0·95
1902	Rescue G M.L. 5065z ...	15·00	22·38	1·88			
1903	Do. ...	33·00	56·68	1·71	48·00	79·06	1·64
1903	Lion G.M.L. 5069z ...	48·00	115·91	2·41			
1904	Do ...	8·00	7·21	0·90	56·00	123·12	2·19
1904	Sentinel G.M L. 5204z...	50·00	31·86	0·63			
1905	Do. ...	5·00	3·72	0·74	55·00	35·58	0·64
1905	Lion G.M.L. 5244z ...	43·00	56·70	1·32	43·00	56·70	1·32
	Total	...	...	...	630·00	865·78	1·37

The Leonidas, G.M.L. 2882z.—This lease, which is the property of the Menzies Mining and Exploration Corporation, Ltd., runs in a more easterly direction than is usual; it was taken up on the dip or western side of a line of lode which outcropped in the Shenton North and Pericles.

There are three groups of workings which may be upon dislocated portions of the same vein, the outcrops of which were worked in the Shenton North to a depth of 100 feet below which it passed into this lease.

At the end of this lease a vertical shaft has been sunk to a depth of 130 feet, from which a level has been driven 70 feet north and 110 feet south, a winze was also sunk upon the lode; and another level driven at 172 feet, north 90 feet and south 110 feet, the reef averaging here a little over 12 inches in thickness, worth 13dwts.

The water-level in these workings was 152 feet, the yield being 150 gallons of salt water per diem.

A little south another vein which outcrops in the Shenton North has been worked by two vertical shafts to the 77-feet level, which is 150 feet long, from which the lode was winzed down on to the 122-feet level, and from this depth the lode was driven on for a length of 300 feet; from the other shaft, a winze was sunk to the 170-feet level which was carried on for a distance of 70 feet.

Farther south but still upon the north-eastern boundary, another small quartz vein has been worked by a vertical shaft to a depth of 143 feet, and a level driven 220 feet, the reef at this level averaging about 12 inches, worth about 10dwts. The returns furnished by the manager are as follow:—3,457 tons of stone have been crushed, which yielded 2,948·71ozs. of fine gold.

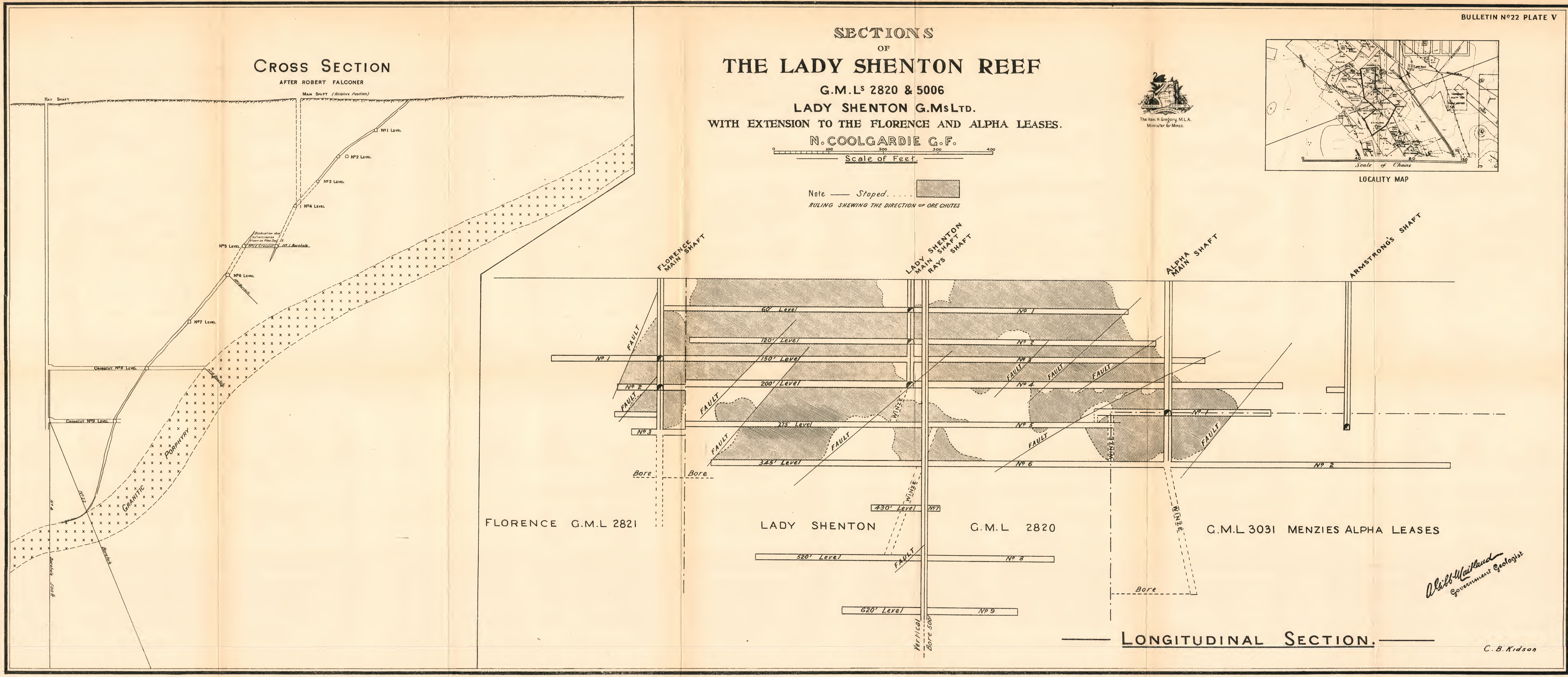
The Florence Gold Mines, Ltd.—This property, which consists of the Florence G.M.L. 2821z, Pericles G.M.L. 2829z, Florence Extended G.M.L., 5203z, and Bantry G.M.L. 3055z, is situated upon the main auriferous belt north and adjoining the Lady Shenton and south of the Friday.

The whole of the work done by this Company may be said to be confined to the Florence lease, the first start being made by sinking a main shaft to a depth of 210 feet near the centre of the property with the object of cutting the Lady Shenton lode. From this shaft cross-cuts were driven in a north-easterly direction at the 60-feet level for a distance of 435 feet, at 110 feet for a distance of 173 feet, and at 160 feet for a distance of 142 feet. In the 60-feet cross-cut a small body of stone was cut dipping south at a distance of 285 feet from the shaft, which was driven on 27 feet west and 135 feet east; this level is connected with the surface where this reef outcrops by an underlay shaft.

This vein was also cut in the two lower cross-cuts, being driven on for a distance of 30 feet east at the 110-feet level and 75 feet west and 90 feet east at the 160-feet level. At the end of this eastern drive, a cross-course dipping to the northward was cut and followed east for 16 feet. This cross-course is evidently the same as outcrops at the surface to the southward of the main shaft. At 200 feet from the surface a small drive east and west was driven from the shaft.

In 1898, the Shenton Company having traced one of these rich shoots up to the south boundary of the Florence, work was started in that locality and what is called the New Main Shaft sunk to a depth of 300 feet and the reef worked by means of three levels. This reef proved to be the top of the Shenton northern shoot which was found to be considerably broken in the lower levels by cross-courses in both properties and to die out before reaching the 300-feet level, whilst to the northward the top of the shoot which dips south ended abruptly upon coming in contact with an east and west cross-course dipping north. This cross-course which terminates the lode has been met with at a distance of 40 feet north of the boundary in the 60-feet level, 100 feet in the 150-feet level, whilst in the 200-feet level it was cut at a distance of 135 feet but the level was not continued because the ore-shoot stops on another cross-course met with in this level at a distance of 80 feet from the boundary which governs its northern extent down to the 260-feet intermediate level below which there is no stone. (Plate V.)

A winze was sunk on the formation from the bottom of the main shaft for a depth of 213 feet, but in it no stone was cut. At 150 feet from the surface the level was continued beyond the cross-course for a distance of 135 feet, from which point cross-cuts were driven 100 feet both east and west without result and thus proving that the Shenton reef did not continue north.



H. J. Pether, Government Lithographer, Perth, W.A.

One of the porphyritic dykes crosses this lease between the two main shafts striking west-north-west and follows the outcrop of the Leonidas lodes, whilst another branch from it was cut in the old main shaft, from which point it appears to run north-west, being cut in the Pericles [6343] and the cross-cut in the Shenton North. These dykes in no case where observed appear to have caused any disturbance so far as the lodes are concerned, since these latter often cross or follow them [6342].

A number of other small segregation veins which cross this property upon the normal north-westerly course have been opened up and are still being worked in the oxidised zone; it is from this source that the entire production of the mine has been derived for the last year or two.

At the north-east corner of the lease is a water-shaft called the donkey shaft, in which the water-level is 200 feet, the yield being estimated at 6,000 gallons per diem, and is stated to be suitable for stock. There is also a water-shaft on the Florence Extended, G.M.L. 5203, which was originally the Fenine, G.M.L. 3051, being 213 feet in vertical depth with a cross-cut west 241 feet and east 120 feet at the 157-feet level and 40 feet east at the 213-feet level. In the Pericles, a shaft has been sunk to a depth of 100 feet and a cross-cut driven 231 feet in a north-east direction in which only small veins of stone were cut.

Table showing the Yield of the Florence Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1896 ...	Florence, G.M.L. 2821z	300 00	465·29	1·55
1897 ...	Do. „	...	129·82	...
1898 ...	Do. „	185 00	439·20	2·37
1899 ...	Do. „	1,205·00	842·05	·70
1900 ...	Do. „	1,735 00	1,430·50	·82
1901 ...	Do. „	1,252 00	1,082·86	·86
1902 ...	Do. „	415·00	400·81	·96
1903 ...	Do. „	365·00	352·56	·97
1904 ...	Do. „	591·00	547·78	·91
1905 ...	Do. „	616·00	664·01	1·08
	Total	6,664·00	6,354·88	·95

The Lady Shenton Gold Mine, Ltd.—This mine, which is situated to the southward of the town, upon G.M.Ls. (1380), 2820z, and 3006z, was not only the first discovery made in this district but it also proved to be by far the richest.

It was discovered in September, 1894, by Messrs. Menzies and McDonald, who were able to trace the outcrop of the lode for a length of over 100 feet by rich specimens scattered upon the surface.

In 1895, Mr. H. Y. L. Brown writes:—"This is on two quartz reefs, one of which strikes north 20 degrees west, and the other east and west. The angle of the underlie averages 45 degrees, but in some places it is less. The gold occurs in quartz, and is often associated with galena and zinc blende. The rocks consist of argillaceous talcose schist above the water-level, with hornblendic slate below. In connection with the quartz-reefs, there is a soft soapy clay which is apparently a decomposed felspathic rock; other shafts near are sunk in green chloritic talcose and argillaceous schists and brown decomposed igneous rocks." * [1036-1044.]

This mine is now full of water to a little above the No. 6 level, whilst above the No. 5 level, which is the lowest that is accessible, practically all the ore has been stoped and most of the stopes filled in. Lately this mine has been in the hands of tributers who have not improved matters from an inspection point of view, since in working portions of the reef which were much disturbed or considered too small by the Company a considerable quantity of rock had to be broken which was not worth raising and was therefore packed below, thus blocking up places that were accessible before.

Both in the stopes and levels very large excavations have been taken out in places; these however do not, it is stated, represent the size of the quartz-vein, but either the enriched rock zone adjoining or a series of veins with interbedded rock.

The mine was first opened by underlay shafts from the surface by means of which some very rich stone and enriched decomposed rock (formation) was worked, but later on a vertical shaft was sunk to a depth of 200 feet where it cut the lode in the hard sulphide zone, and from the bottom of this shaft the No. 4 level was driven. Above this level the country softens rapidly, passing from schistose rock into a yellow and brown argillaceous formation. The Nos. 5 and 6 levels were worked by a winze sunk close to the shaft bottom, whilst another main winze was sunk further north from the No. 5 to the No. 8 level. (Plate V.)

In the west lease a main shaft was sunk in very hard country to the dip called Ray's shaft to a depth of 620 feet; this shaft is now connected with the Nos. 8 and 9 levels by cross-cuts. [6341.]

Although no water was encountered in the original workings it was cut in this shaft at a depth of 100 feet, below which a water-bearing zone of 200 feet was passed through, the yield varying from 1,000 to 6,000 gallons per diem.

All the stopes are situated above the No. 6 level, for below this, in spite of the fact that a strong reef was followed down upon which a considerable quantity of work has been done, no ore of a payable character was met with.

The ore-body in this mine was of a composite character, *i.e.* it consisted of a number of more or less lens-shaped quartz veins or

* *Loc. cit.*, p. 4.

pipes (elongated lenses) which follow the foliation planes of the rock in a south-westerly direction, the dip of the planes varying here from 53 degrees at the north end of the mine to 45 degrees at the south.

The auriferous veins lie upon these planes, dipping diagonally across them at an angle of 34 degrees to the southward, thus the northern shoot that was worked in the Florence dips into the Shenton whilst the main shoot in this mine dips into the Alpha.

In the oxidised zone the character of these shoots was not well defined owing to the presence of a large number of minor veins and the enrichment of the adjoining decomposed rock due to concentration; as a consequence the true character of this ore body was not understood until the more solid country was reached where the veins began to contract into pipes. The impression gathered with regard to this lode some years ago was that a large rich formation enclosing a more or less broken quartz reef extended from one end of the upper levels to the other; whilst in the sulphide zone the quartz-reef had formed into a definite solid body of variable size enclosed in a formation the walls of which had not been cut.

Near the surface the whole of the stone and formation was worked for a length of something over 600 feet, whilst below this the breadth of the ore body steadily increased until at the No. 4 level (200 feet) it extended for a length along the levels inclusive of the Florence of over 1,000 feet. Directly this level was passed and the sulphide zone entered the lode split up into three definite shoots with blank ground between them, whilst below the three shoots gradually contracted until at a vertical depth of about 300 feet they died out altogether.

The quartz in this mine has no defined walls or casing, and where a semblance of a wall is met with it is found upon careful examination to be only one of the cleavage planes of the rock upon which the vein has been formed. Individual quartz-veins, as far as can be judged from the small veins now being worked, have no connection with each other but lie upon parallel planes of cleavage often overlapping each other, or in the case of three may lie in a splice-like manner. No signs of fissure plane can be observed although often in driving small threads of quartz have been followed for a considerable distance, which gave the impression that such a plane was being followed. These veins were often most misleading, since upon several occasions in this mine these were followed until they died out, whilst other ore-bodies existing upon parallel planes were missed and not discovered until later by cross-cutting. The ore-body in this mine is considerably disturbed by a series of cross-courses, some of which are represented by solid barren quartz-veins. These cross-fissures, which mostly run in a more or less east and west direction and dip to north, generally follow the cross joints of the rock and have in cases displaced the ore body, the throw being either east or west according to whether

they are normal or reversed faults. They are in all probability inclined V faults, the southernmost of the pair being more oblique than the northern.

In places in this mine two or more minor faults have apparently intersected the lode in close proximity, causing such considerable disruption that even driving the levels through them was attended with considerable danger and difficulty, whilst certain portions of the ore-body could not be worked. This ore in many places has now been taken out by the tributers but it shows in the accompanying plan of the stopes as solid ground. (Plate No. V.)

Although these faults have undoubtedly caused considerable trouble in places it is quite apparent that many of the so-called displacements are nothing of the kind but simply represent the southern termination of one vein, whilst another has been met with upon parallel planes either east or west.

At the present time about the only point in the mine where the true pitch of the ore-pipes can be observed is in what is called the P. Grade, which is situated near the north-east corner of the Alpha between Nos. 4 and 5 levels. The shoot here has a well-marked pitch of about 34 degrees south, but comes to a sudden stop upon the cross-course which has at this point dislocated the lode. If the grade of this shoot is followed upwards to the surface through the oxidised zone it will be found to cross the No. 2 level to the eastward of the main shaft and to come out upon the surface at the point where the original rich outcrop was discovered, whilst if followed downwards after allowing for the throw it will be found to continue to the bottom level of the Alpha. If this is taken as the true dip of the ore-shoots in this mine (which is supported by the fact that the grade is identical with the ore-shoots in the other mines) it becomes apparent at once that there are three main shoots all of which terminate at the No. 6 level, whilst at the south end there is either another short one or, which is more probable, it represents the splaying out of this shoot similar to the Queensland Menzies. This is not at all an uncommon characteristic of this class of lode, the ore-body presenting the appearance of a series of inclined V's, the apex of which points south, the lower side dipping at an angle of about 35 degrees, whilst the upper, which is much more acute, is bounded by a line which dips at an angle of from 70 to 75 degrees; this is on the inclined plane, not as appears in the foreshortened vertical section of the ore-shoots, Plate V.

This splaying out of the ore-shoot towards the surface in a more or less vertical manner causes the various distinct chutes met with below to unite in the upper levels and in consequence to appear like one continuous ore-body.

It is not at all clear that the strong reef which is reported to have been cut in the workings below the No. 6 level is the

continuation of the rich ore body worked above, but this point could not be investigated on account of the water. It would be quite exceptional to find a vein of this class continuing strongly in depth without gold values, the usual character being for a rich vein to gradually decrease in size and to finally die out, and this is said to have been the case at the terminations of the ore-shoots at the No. 6 level. It is quite possible that a barren lenticular body has formed at most generally parallel to these termini, but it is much more probable in this case that the barren footwall reef has been cut and followed down since this has the appearance of being a much more permanent body.

In any case the deeper workings are so situated as to have little prospect of cutting the ore-shoots if they continued, and as will be seen by reference to Plate No. V. that the No. 7 level and the extension south end of No. 8 could only possibly have cut the Florence shoot, which being the northern chute, if this ore-body follows the general character, would be the least likely to continue.

The other ore-shoots lie well to the southward of these workings and would rapidly cross the boundary into the Alpha, this however is apparently not the case as is demonstrated by the extensive works carried out upon the last-mentioned property, a description of which will be given next.

The cross-section of the mine reproduced was prepared by Mr. Robert Falconer, the manager, and shows the relation of the Shenton lode to a granite dyke which lies to the eastward. (Plate V.)

This dyke can be traced at points upon the surface and by the dumps along its course for a considerable distance, and is the same which crosses the Florence Mine after splitting into two branches. Although a solid porphyritic granite was cut in the bore at the bottom of the main shaft and also in the extension east of the No. 8 cross-cut, this dyke has been subjected to the same conditions such as hydration with attendant crushing that have changed the diorite into schists, the alteration in this case being from granite to gneiss, gneiss to mica and sericite schist, the foliation of which is identical with that of the surrounding rocks. [6336.]

This added to the fact that in no instance has a dyke been known to dislocate a lode whilst the quartz-bodies are found in and crossing them proves their prior existence to the lodes, which latter were apparently not formed until after hydration had taken place.

This Company has employed every practicable means at its disposal in order to determine the extension of the ore-body, its leases being riddled with drives, cross-cuts, winzes and bore-holes; therefore with the exception of small parallel pipes of stone there is apparently little prospect of a continuation of the ore-shoot being discovered.

Table showing the Yield of the Shenton Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1896 ...	Lady Shenton, G.M.L. 2820z ...	1,749·00	5,833·92	3·34
1897 ...	Do. do. „	4,832·00	14,137·92	2·92
1898 ...	Do. do. „	7.328·00	20,090·48	2·73
1899 ...	Do. do. „	13,779·00	19,536·48	1·41
1900 ...	Do. do. „	16,341·00	17,552·40	1·08
1901 ...	Do. do. „	14,989·00	19,306·17	1·29
1902 ...	Do. do. „	15,900·00	17,508·18	1·10
1903 ...	Do. do. „	16,152·00	13,587·07	0·84
1904 ...	Do. do. „	1,119·00	675 87	0·60
1905 ...	Do. do. „	4,091·00	3,872·82	0·95
	Total	**96,280·00**	**132,101·31**	**1·37**

NOTE.—This reef should be credited with some 5,000 ozs. from the Florence and 10,000 ozs. from the Alpha, but no record of the exact quantity obtained from it is available.

The Menzies Alpha Leases, Ltd.—This property, which consists of the Stirling, G.M.L. 3031z, and the Alpha, G.M.L. 3011z, is situated immediately south of the Lady Shenton, but it was not until 1900 that the rich ore-shoot worked in that mine was found to extend into this property. Previous to this mining had been carried on upon the Stirling lease upon a reef which crossed the boundary about 160 feet from the north-east corner peg, which was supposed to be the extension of the Shenton reef; this now appears either to be the displaced continuation of the barren reef which lies to the eastward or upon the footwall side of it, or a pyrites lode which has been met with in the mine upon the hanging wall side. At the south end of this reef, which outcrops for a distance of about 300 feet, a vertical shaft, called Armstrong's shaft, has been sunk to a depth of 276 feet, which passed through the reef at 150 feet. At a depth of 205 feet a crosscut was driven 25 feet west, at which point it cut the reef and followed it for a distance of 40 feet. From the bottom of the shaft a crosscut was driven 110 feet to the eastward, but in it no lode was cut [**750, 754**].

A bore was then put down at the north-east corner peg, which cut the lode at a depth of 250 feet. A main shaft was sunk 123 feet south of this point to a depth of 335 feet, with a crosscut at 250 feet from which No. 1 level was driven, whilst No. 2 was driven from the bottom of the main shaft. (Plate V.)

In the No. 1 level the ore body extended south for a distance of 220 feet from the Shenton boundary, after which it died out, no continuation of it being discovered in the level which was continued for another 120 feet.

The No. 2 level was driven from the main shaft north to the boundary where the small terminal points of the shoot were met with; in places this also continued for 40 feet south of the shaft,

after which no further ore was discovered, although 480 feet were driven in hard aphanatic diorite [6330].

In this level the last 300 feet were driven in a solid, barren quartz reef, which gradually formed and which is, in all probability, the same vein as was cut in the Armstrong shaft; however, no connection between these workings has yet been made.

From this level a considerable amount of crosscutting and boring has been done without result, whilst, from the bottom of the main shaft, a winze has been carried down on the dip of the formation for a further distance of 363 feet. From this winze a certain amount of boring and crosscutting has been done, which must, if the Shenton ore-shoot extended in this direction, have cut it, or, at least, some indication of it.

From this, it appears that the Shenton ore-shoots do not extend below the No. 2 level in this mine, which is the continuation of the No. 6 in the other, or, in other words, these veins cease to exist below the level to which the action of hydration has extended.

Upon the Alpha lease, which lies to the southward of the Stirling, a considerable amount of work has been done upon some small rich reefs that were met with near the south-east corner; one of these, which follows the general north-west course, has been worked by a number of underlay shafts to a depth of 60 feet, and, below this, by means of a winze to 100 feet. From this reef some rich stone was raised; but, since it is small, and the country hard below the existing workings, it has not been considered advisable to continue deeper. The line of the reef northward seems pretty constant, to judge by the number of prospecting shafts sunk upon it, but, immediately south, on approaching the Little Wonder, it is extremely broken, the dip changing even in a short distance.

Table showing the Yield of the Alpha Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1896 ...	Menzies Alpha Leases—Stirling, G.M.L. 3031z, and Alpha, G.M.L. 3011z	53·00	324·55	6·12
1897 ...	Do. „ ...	427·00	1,164·70	2·72
1898 ...	Do. „ ...	263·00	1,431·52	5·44
1899 ...	Do. „ ...	199·00	559·35	2·81
1900 ...	Do. „ ...	200·50	239·37	1·19
1901 ...	Do. „ ...	676·50	822·42	1·21
1902 ...	Do. „ ...	3,853·00	4,020·76	1·04
1903 ...	Do. „ ...	4,746·50	6,015·21	1·26
1904 ...	Do. „ ...	343·50	476·27	1·38
1905 ...	Do. „ ...	311·00	483·59	1·56
	Total	**11,073·00**	**15,537·74**	**1·40**

The Alpha South, G.M.L. 3098z, is situated south of the Alpha, and was until quite recently held by the Menzies Mining and

Exploration Corporation, Ltd. Little work has been done upon it; the deepest shaft being 80 feet, from which 65 tons of stone were crushed, yielding 64·40ozs. of gold.

The Meriyulah, G.M.L. 4960z, is situated south of the Alpha South, and upon it some small quartz veins have been worked in the oxidised zone for the last six years.

Table showing the Yield of the Meriyulah Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1900 ...	Meriyulah G.M.L. 4960z	9·00	10·93	1·21
1901 ...	Do. „	37·00	62·76	1·69
1902 ...	Do. „	23·00	30·18	1·31
1903 ...	Do. „	22·00	28·83	1·31
1904 ...	Do. „	107·00	91·12	·84
1905 ...	Do. „	107·00	120·13	2·05
	Total	305·00	343·95	1·12

The Heart's Content, G.M.L. 4947z, is a small lease which lies to the south of the last, and was worked in the years 1900 and 1901, a shaft being sunk to a depth of 70 feet on a small quartz vein from which 44 tons of stone were raised which yielded 82·37ozs. of gold.

The Menzies Mining and Exploration Corporation, Ltd.—This Company owns a number of leases mentioned previously under their distinctive names, but this group of leases which constitute the head quarters of the Company consist of the Castle Blarney, G.M.L. 3106z; Lady Shenton East, G.M.L. 2843z; Lady Shenton Extended, G.M.L. 2844z; and Shenton South East, G.M.L. 4948z, all situated to the eastward of the Lady Shenton.

In the Extended, a small cross vein which strikes a little east of north, and dips to the south at an angle of 45 degrees has been worked by means of two underlay and one vertical shaft to a depth of 158 feet. From these levels have been driven at 62 feet, 200 feet long; at 99 feet, 200 feet long; and at 146 feet, 130 feet long, and from these workings 1,453 tons of stone were raised and crushed, yielding 1,157·47ozs. of fine gold.

On the Shenton East, an east and west reef consisting of two parallel pipes of stone have been worked to a depth of 199 feet by three underlay shafts with short levels and crosscuts, at 51 feet, 85 feet, 122 feet, 164 feet, and 199 feet. A main vertical shaft has also been started and sunk to a depth of 218 feet, but it has not yet been connected with the other workings on the lode. In this shaft, a supply of good stock water equal to 1,000 gallons per diem was cut at a depth of 155 feet. From this mine 1,770 tons of stone were crushed, which yielded 2,440·12ozs. of gold. The veins cut and worked in these two properties do not appear to be cross courses, but have simply been formed by the buckling of the strata.

The Shenton South-East, G.M.L. 4948z, is south of the Lady Shenton and Shenton Extended; it consists of portions of the Lady Shenton No. 1, G.M.L. 2824, and Lady Shenton South Extended, G.M.L. 3458z, the former of which was owned by the Menzies Gold Reefs Proprietary, Limited, who sank a shaft 100 feet and crosscut from the bottom 450 feet west in the hopes of cutting the Shenton lode; they also sank two shafts near the north boundary which are connected by a crosscut 150 feet long. With the exception of this, little work has been done upon this lease from which a parcel of 37 tons of stone was crushed, yielding 37·80ozs. of gold. Upon the Castle Blarney, which lies to eastward of the Extended and between it and the Railway, a few prospecting shafts have been sunk, the deepest of which is 50 feet.

The Golden Age or Little Wonder Group.—This group of leases cover, or at one time have covered, portions of the old leases Golden Age, G.M.L. 2,830z; Adelaide, G.M.L. 3378z; and Lady Shenton No. 1, G.M.Ls. 2424z and 3074z.

The Golden Age was worked in the earliest days of this field by the Menzies Golden Age Gold Mine, Limited, upon a small but rich east and west reef, the shoot in which dips to the south to the 80 feet level, beneath this, although considerable prospecting was done in serpentine schist, no continuation of the vein was met with. Five shafts were sunk, the total depth of which is 730 feet, the deepest being 260 feet, in which the water level was cut at 173 feet; besides these shafts 180 feet of winzing has been done, 1,470 feet of drives and crosscuts. The lode is apparently of the buckled type as there is no indication of a cross reef, the only outcrop being a large pyrites body which follows the normal course and is probably the same as cut to the northward in the Shenton No. 1.

In some portion of this mine the porphyritic granite dyke was cut out, and from these dumps a finer series of specimens were obtained illustrative of its gradual change into sericite schist [6332-4]. Portions of this lease have more recently been worked as the Federation, G.M.L. 4959z; and Golden Age, G.M.Ls. 5005z, and 5092z, whilst the Little Wonder also occupies a part.

Table showing the Yield of the Golden Age Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1896 ...	Menzies Golden Age, G.M.L. 2·30z	50·00	285·48	5·70	...	...	...
1897	Do.	202·50	722·20	3·56	...	...	...
1898	Do.	...	...		...	...	...
1899	Do.	40·00	51·32	1·28	292·50	1,059·00	3·62
1900	Federation, G.M.L. 4959z	30·00	13·19	·43	30·00	13·19	·43
1901	Golden Age, G.M.L. 5005z	31·00	27·75	·89	...	...	...
1902	Do. ,,	45·0	13·34	·29	76·00	41·9	·54
1903	Do. 5092z	27·00	46·69	1·73	...	...	...
1904	Do. ,,	10·00	1·96	·19	...	...	...
1905	Do. ,,	10·00	6 20	·62	47·00	54·85	1·17
	Total	...		...	445 50	1,168·13	2·62

The two leases named **Lady Shenton No. 1**—28247z and 3074z, which were owned by the Gold Reefs Proprietary, Limited, have, besides the Shenton South-East, G.M.L. 4948z, in the north, being divided up into the **Menzies Main Reef**, G.M.L. 5149z; **Golden Crown**, G.M.L. 4973z; **Hayles and Taverstocks United**, G.M.L. 5000z; **Little Wonder North**, G.M.L. 5171; and the balance of the **Little Wonder**, G.M.L. 5189z.

The original Company, besides the 450 feet and 150 feet of crosscutting mentioned previously, sank several shafts, in one of which a large pyrites lode assaying from two to three pennyweights was cut at 100 feet, being probably the same as that met with in the Golden Age, G.M.L. 2830z.

Upon these minor leases, as a rule, little has been done with the exception of raising a little stone from the old workings.

Table showing Yield of Gold from the above-mentioned Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1904 ...	Menzies Main Reef, G.M.L. 5149z ...	37·00	10·00	·27
1901 ...	Golden Crown, G.M.L. 4973z	16·00	35·42	2·21
1901 ...	Hayles & Taverstock's United, G.M.L. 5000z	44·00	56·48	1·28
1902 ...	Hayles & Taverstock's United, G.M.L. 5000z	40·00	50·67	1·26
	Total	**84·00**	**107·15**	**1·27**

The Little Wonder, G.M.L. 5189z, is situated to the eastward of the Alpha South, G.M.L. 3098z, upon portion of what were the Shenton No. 1, G.M.L. 3074z, and the Golden Age, G.M.L. 3830z.

There are several lines of stone in this lease, but until recently most of the work was confined to the Golden Age and Central lines, lately, however, work has been started more to the westward, upon a promising ore body.

Table showing the Yield of the Little Wonder Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom.	Average rate per ton.
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1903 ...	Little Wonder, G.M.L. 5139z	14·00	15·96	1·14	14·00	15·96	1·14
1904 ...	Do. G.M.L. 5163z	94·00	329·98	3·51	94·00	329·98	3·51
1904 ...	Do. G.M.L. 5189z	113·00	129·29	1·12	...	...	...
1905 ...	Do. G.M.L. 5189z	163·00	451·80	2·77	276·00	581·09	2·10
	Total	...	...	...	**384·00**	**927·03**	**2·41**

The Adelaide, G.M.L. 3378z, is an old lease which lies to the eastward of the Golden Age, and upon it a good many prospecting shafts have been sunk. Lately a portion of it has been worked as the Baden Powell, but so far only in the oxidised zone upon small quartz veins.

Table showing the Yield of the Baden Powell Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1899 ...	Adelaide, G.M.L. 3378z	13·50	17·14	1·27
1903 ...	Baden Powell, G.M.L. 5089z	17·00	18·20	1·07
1904 ...	Do. 5241z	127·00	204·00	1·60
1905 ...	Do. „	19·00	8·63	·45
	Total	**176·50**	**247·97**	**1·40**

To the south and south-west of these are the **Cosmopolitan,** G.M.L. 4961z; **Broken Seal,** G.M.L. 5022z; and **Nugget,** G.M.L. 5209z, upon which a number of shallow workings have been sunk upon small quartz veins.

Table showing the Yield of the above-mentioned Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1900 ...	Cosmopolitan, G.M.L. 4961z	42·00	18·13	·43
1901 ...	Do. „	10·00	5·58	·55
	Total	**52·00**	**23·71**	**·45**
1902 ...	Broken Seal, G.M.L. 5022z	35·00	25·66	·73
1904 ...	Nugget, G.M.L. 5209z	36·00	98·03	2·43
1905 ...	Do. „	51·00	46·89	·92
	Total	**122·00**	**170·58**	**1·39**

McClay's Welcome Gold Mining Company, N.L.—This Company, which owned Taipo, G.M.L. 3744z, and Taipo South, G.M.L. 3840z, which are situated to the southward of the Golden Age, worked these leases in 1897 and 1898 by means of a 62 feet north shaft from which a level was driven south from the bottom for a distance of 113 feet to the next shaft which is 132 feet deep with a level nine feet south at the 120 feet. The south shaft is on the northern boundary of the south lease and is 102 feet deep.

The vein in these workings is small and of low value, being associated with a porphyritic granite dyke [**6335**].

After the Company abandoned these leases, they have been held under the names of Golden Star, G.M.L. 4907z; Golden

Butterfly, G.M.L. 4997z; Welcome, G.M.L. 5101z; and Homeward Bound, G.M.L. 5173z, but little work has been done of a developmental character.

Table showing the Yield of McClay's Welcome Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom.	Average rate per ton.
		tons.	ozs.	ozs.	tons.	ozs	ozs.
1897 ...	Taipo, G.M.L. 3744z ...	65·00	36·03	·54	...	...	...
1898 ...	Do.	17·00	12·74	·74	82 00	48·77	·59
1898 ...	Golden Star, G.M.L. 4907z	19·00	14·13	·74	19·00	14·13	·74
1901 ...	Golden Butterfly, G.M.L. 4997z	120·00	36·37	·30	120·00	36·37	·30
1904 ...	Welcome, G.M.L. 5101z	90·00	24·53	·27	90·00	24·53	·27
1904 ...	Homeward Bound, G.M.L. 5173z	33·00	4·82	·14	33·00	4·82	·14
	Total	...	...	...	344·00	128·62	·37

The Alexandria, or **Sherez,** G.M.L. 3098z, is situated at the north end of a parallel line of reef to the westward of the Lady Shenton. A few shafts have been sunk varying in depth from 60 to 100 feet, from which 171 tons of stone were raised, which yielded 201·40ozs. of gold.

The Africander, G.M.L. 5253z, is immediately south of the last mentioned, and upon it a great deal of shallow work has been done, small veins being apparently worked from the surface down in the oxidised zone and for considerable lengths. It has been worked off and on since 1898 either by companies or parties of working miners.

Table showing the Yield of the Africander Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom.	Average rate per ton.
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1898 ...	Africander, G.M.L. 3034z	20·00	35·92	1·79			
1899 ...	Do. ,,	169·00	214·50	1·21	189·00	250·42	1·32
1900 ...	Do. ,,						
1901 ...	Do. ,,						
1902 ...	Do. 4984z	42·00	40·62	·96			
1903 ...	Do. ,,	5·0	15·72	3·14	47·00	56·34	1·19
1904 ...	Menzies Fortuna, G.M.L. 5136z	115·00	118·81	1·00			
1905 ...	Do. ,,	19 00	20·93	1·10	127·00	139·74	1·09
1905 ...	Africander, G.M.L. 5253z	34·50	38·09	1·10	34·50	38·09	1·10
	Total	...	...	...	407·50	484·59	1·19

The London and Coolgardie Explorers, Ltd.—This company owned the Last Chance, G.M.L. 3116z, and Mersey, G.M.L. 3118z, which lie immediately south and east of the Africander, and upon this a good deal of shallow sinking along the course of small ore bodies has been carried on for a number of years.

Table showing the Yield of the London and Coolgardie Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1898 ...	Last Chance, G.M.L. 3116z	110·00	218·88	1·98
1899 ...	Do. „	204·50	150·58	·73
1901 ...	Do. „	10·00	12·14	1·21
1902 ...	Do. „	16·00	12·63	·78
1903 ...	Do. „	31·50	53·97	1·71
1904 ...	London and Coolgardie, G.M.L. 5013z	12·00	6·78	·56
	Total	**383·00**	**454·98**	**1·19**

The Crown Cross Group.—South of the last mentioned, and upon the same line of country, is the Crown Cross, G.M.L. 4912z, upon which a long line of reefs appears to have been worked by a series of shafts to a depth of about 100 feet. One shaft has been sunk to a depth of 200 feet, which is the water level.

The other leases of this group to the southward also appear to have been continuous lines of reefs, to judge from the old workings.

Table showing the Yield of the Crown Cross Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1897 ...	Crown Cross, G.M.L. 4860z	11·00	9·34	·84
1898 ...	Do. „	223·00	172·32	·77
1899 ...	Do. G.M.L. 4912z	60·00	160·22	2·67
1900 ...	... ...	111·00	346·54	3·09
1901 ...	... ...	182·00	455·01	2·50
1902 ...	... ...	11·00	8·43	·76
1903 ...	... ...	146·00	399·48	2·73
1904 ...	... ...	66·50	104·53	1·57
1905 ...	... ...	18·00	10·82	·60
	Total	**825·50**	**1,666·69**	**2·01**
1900 ...	Ivy, G.M.L. 4942z	15·00	1·58	·10
1901 ...	Crown Cross South Extended, G.M.L. 4979z	101·00	498·01	4·53
1902 ...	Westralia Menzies, G.M.L. 5034z ...	...	5·75	...
1903 ...	Do. „ ...	·50	92·66	184·12
1904 ...	Do. „ ...	20·00	32·56	1·14
	Total	**136·50**	**630·56**	**5·17**
1900 ...	Nil Desperandum, G.M.L. 4941z ...	74·00	152·55	2·06
1901 ...	Do. „ ...	13·00	43·22	3·32
1904 ...	Victoria Cross, G.M.L. 5131z	32·00	7·48	·23
	Total	**119·00**	**203·25**	**1·70**

The Warrior, G.M.L. 3048z. — This lease was worked and owned by the Warrior Menzies G.M. Co., N.L. (late Wallaroo Menzies G.M. Co., N.L.), which Company also owned the Gem, G.M.L. 3235z, and the Monte Christo Battery, on G.M.L. 3398z.

There are three lines of lode upon this property, called respectively the main lode and the eastern and western.

The main lode was first opened upon by an underlay shaft 115 feet deep, from the bottom of which a level was driven 280 feet south, the lode being about four feet in thickness. [**751, 755, 6371.**]

A main vertical shaft was sunk about 200 feet to the westward of the underlay shaft to a depth of 200 feet without cutting water. At 100 feet from the surface a crosscut was driven east 130 feet, which cut the level 100 feet south of the underlay shaft. From this level a winze was put down 60 feet at a point 50 feet south of the crosscut.

At the 200 feet level a crosscut has been driven 75 feet east, which cut the lode, the latter being driven on for a distance of 70 feet south. A winze was sunk from this level at a point 10 feet south of the crosscut to a depth of 30 feet, the stone being about four feet six inches thick.

On the western lode there are three shafts—a vertical 110 feet, one underlay 80 feet, and one 115 feet with 272 feet of drives. Most of the work has been confined to the upper levels, where the lode was from two feet to two feet six inches in thickness, but a little has been done at 110 feet, where it is three feet six inches thick.

On the eastern reef an underlay shaft has been sunk 75 feet and a level driven 90 feet, in which the stone is three feet in thickness. Another shaft has been sunk on the line of this lode to cut it at 129 feet, but it is only down 90 feet at present.

A considerable amount of stoping has been done from the various levels, whilst the quantity of stone raised and crushed is given in the following table:—

Table showing the Yield of the Warrior Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1898 ...	Warrior Menzies, G.M.L. 3048z ...	200·00	184·89	·92
1899 ...	Do. „ ...	212·00	119·48	·56
1900 ...	Do. „ ...	298·00	200·88	·67
1901 ...	Do. „ ...	340·00	161·73	·47
1902 ...	Do. „ ...	80·00	39·13	·48
1903 ...	Do. „ ...	23·00	22·95	·99
1903 ...	Warrior, G.M.L. 3048z	205·00	205·21	1·00
1904 ...	Do. „	344·00	172·26	·50
1905 ...	Do. „	101·00	41·02	·40
	Total	**1,803·00**	**1,147·55**	**·64**

The Indus, G.M.L. 4291z; **Opal,** G.M.L. 5100z; **Battlers' Rest,** G.M.L. 5143z; and **Lucky Prop,** G.M.L. 5127z, were small leases situated to the south of the Warrior, upon which a little work was done.

Table showing the Yield of the above-mentioned Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1899 ...	Indus, G.M.L. 4291z	16·00	2·76	·17
1904 ...	Opal, G.M.L. 5100z	30·00	4·71	·15
1903 ...	Battlers' Rest, G.M.L. 5143z	10·00	12·97	1·29
1904 ...	Do. „	11·00	5·06	·46
	Total	**67·00**	**25·50**	**·38**
1903 ...	Lucky Prop, G.M.L. 5127z	**72·00**	**17·96**	**·24**

The Lady Harriet Leases, G.M.Ls. 4972z and 5003z.—This area was owned by the Menzies Pioneers, Ltd., which Company held it until 1898, since which time it has been owned locally.

At one time there appears to have been a considerable amount of dryblowing carried on upon this lease, whilst to the westward a large number of shafts have been sunk, apparently upon an alluvial lead, but no record appears to exist with regard to the quantity of gold obtained.

The original Company did a very considerable amount of shaft-sinking, driving, and crosscutting on this property upon a line of lode which strikes about 35 degrees west of north, and dipping to the southward at varying angles, though usually steep. The ore occurred in pipes or shoots, and is pretty well worked out in the upper levels.

The deepest shaft is 200 feet, and in this salt water was struck at a depth of 160 feet (the water level is now 188 feet).

Recently the Lady Shenton Gold Mines, Ltd., took an option on this property when, according to the manager's report, a large quantity of sinking, driving, and crosscutting was done below the existing workings. In summing up the situation, Mr. Falconer, the manager, says:—"Payable stone had been crushed, and was then showing in four different shoots. The shoot at No. 1 shaft has

been proved to be non-existent at the 187 feet level over a length of 229 feet. The shoot in the No. 2 shaft has been proved to have a total length of 110 feet at the 40 feet level, and 26 feet at the 100 feet level, and an average value of 10dwts. The shoot in No. 3 shaft has not been completely explored, but, judging from the work already done, is very probably only a short pipe. The shoot in No. 4 shaft has been proved at the 187 feet level to have a length of 20 feet, a width of five feet, and an average value of 30dwts." *

Even at the moderate depth of 187 feet, where most of this work was carried out, the country was so hard as to necessitate the use of rock drills. It will be seen from the above that the lodes here are of a similar character to those further north, *i.e.*, rich pipes of ore which decrease in size and die out as they approach the hard country.

At the south-east end of this line of reef, a cross reef from the outcrop of which the dryblowing patch starts; this latter has been worked both in this lease and in that adjoining, called the Olivia, from which it is named. The reef strikes in a north-easterly direction, and dips to the north-west; its junction with the Harriet Reef in all probability feed the alluvial patch.

Table showing the Yield of the Lady Harriet Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom.	Average rate per ton.
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1897 ...	Lady Harriet, G.M.L. 2822z (Menzies Pioneers, Ltd.)	613·00	689·40	1·12			
1898 ...	Do.	...	28·43	...	613·00	717·83	1·17
1899 ...	Lady Harriet, G.M.L. 2822z	334·00	280·74	·84			
1900 ...	Do. ...	425·00	364·71	·85	759·00	645·45	0·88
1901 ...	Lady Harriet, G M.L. 4972z	320·00	241·98	·75			
1902 ...	Do. ...	295·00	472·75	1·60			
1903 ...	Do. ...	112·00	405·85	3·62			
1904 ...	Do. ...	631·00	474·09	·75			
1905 ...	Do. ...	819·00	488·71	·59	2,177·00	2,083·38	·95
	Total ...	...	...	...	3,549·00	3,446·66	·97

* Report to the directors of the Lady Shenton Gold Mine, Limited.

To the south of the Lady Harriet there are several small properties upon which a little work has been done, which have yielded the following returns:—

Table showing the Yield of the Reefs south of the Lady Harriet.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1898 ...	Ourine, G M.L. 4877z	33·00	22·83	·76
1898 ...	Jimgellie, G.M.L. 4877z	42·00	28·78	·68
1898 ...	Three Battlers, G.M.L. 4871z ...	57·00	40·09	·72
1902 ...	Coronation Gift, G.M.L. 5064z ...	29·00	22·25	·77
	Total	**86·00**	**62·34**	**·72**
1901 ...	Home Signal, G.M.L. 4993z	5·00	4·94	·98
1903 ...	Great Hope, G.M.L. 5090z	12·50	21·85	1·74
	Total	**17·50**	**26·79**	**1·52**
1897 ...	Daisy Bell, G.M.L. 4061z	49·00	47·11	·96
1898 ...	Do. „	23·00	22·23	·96
1903 ...	Bellinger, G.M.L. 5114z	2·00	·28	·14
1904 ...	Do. „	29·00	8·74	·30
	Total	**103·00**	**78·36**	**·76**
1898 ...	Ancient Britain Extended, G.M.L. 4007z	**26·00**	**20·79**	**·78**

The Maori Chief, G.M.L. 4987z; the **Sefton,** G.M.L. 5080z, or **Double Event,** G.M.L. 5135z; and the **Eureka,** G.M.L. 5078z, are situated upon the eastern side of the Railway Line to the eastward of the Golden Age, G.M.L. 2830z.

Little has been done on these, with the exception of the Maori Chief, G.M.L. 4987z, the workings on which consist of a main shaft 96 feet deep, from which a crosscut has been driven at the 70 feet level 33 feet east to a level which is 110 feet long, which is also connected with the surface by a vertical and an underlay shaft.

The ore-shoot, which dips south, and is about 18 inches wide has been driven upon for 65 feet in the southern portion of this level; it has been worked up to the surface and is now being followed down by the means of winzes.

Table showing the Yield of the Maori Chief and other Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1899 ...	Maori Chief, G.M.L. 4914z	7·00	9·27	1·32
1900 ...	Do. „	296·00	209·14	·73
1901 ...	Do. 4987z	90·00	44·90	·49
1902 ...	Do. „	74·00	88·51	1·19
1903 ...	Do. „	...	...	...
1904 ...	Do. „	96·00	74·28	·74
1905 ...	Do. „	283·00	266·99	·94
	Total	**543·00**	**474·68**	**·87**
1903 ...	Sefton, G.M.L. 5080z	8·10	12·66	1·56
1904 ...	Double Event, G.M.L. 5135z	36·00	44·15	1·22
1905 ...	Do. „	38·00	17·05	·34
	Total	**82·10**	**73·86**	**·89**

The Menzies Lady Mary, G.M.L. 3121z, lies a few chains to the eastward of the last, and from it 14 tons of stone were crushed in 1897, which yielded only 1·22 ounces of gold. The balance of the stone, which is of a ferruginous character, is still at grass. [**792, 793, 798.**]

Miscellaneous Leases.

Upon the western side of the Railway Line, and running towards it and eventually crossing it, is a line of scattered leases upon which a considerable amount of development work was done in places by Companies during the boom time, but since their abandonment they have been worked by prospectors in a desultory manner.

This line starts at the northern end with the Olive Branch, G.M.L. 5112z, which is situated upon the side of an immense barren quartz blow, forming a portion of the dividing ridge between the northern and south-western watershed. South of this lie the two leases, both named the Lincoln, G.M.Ls. 5134z, 5181z; then the Lady Sarah, G.M.L. 5009z, afterwards called the Lady Fanny, G.M.L. 5179z; then the Queenslander, G.M.L. 5126z; and Two Walters, G.M.L. 5207z.

Next, upon a steep laterite hill to the east of the Lady Harriet, G.M.L. 4972z, are the old leases formerly known as the Monte Christo, G.M.L. 3398z; and Gem, G.M.L. 3235z, which were owned by the Warrior Menzies Company (late Wallaroo). This Company did a considerable amount of work upon them, but, apparently, did not succeed in discovering a payable lode. A battery was, however, erected on the ground, and a water supply obtained by sinking, the stone crushed coming from the Warrior, G.M.L. 3048z.

These leases have since been held as the Sailor, G.M.L. 5109z; Bristol, G.M.L. 5116z; Busy Bee, G.M.L. 5105z; and Adelaide, G.M.L. 5128z; but have, apparently, never yielded rich stone. On

the GEM EXTENDED, G.M.L. 4957z, now the MENZIES STAR, G.M.L. 5118z, a number of shafts have been sunk upon a vein of the usual type, which has been worked in the oxidised zone since 1897 by various parties.

South of this, again, are the LUCKY VENTURE, G.M.L. 5151z, and LORD NELSON, G.M.L. 5111z; and to the south-west of these the KLONDYKE, G.M.L. 5226z; the GREAT KLONDYKE, G.M.L. 4853z; the BRITANNIA, G.M.L. 4850z; the HORNET'S NEST, G.M.L. 4998z; and the GOLDEN HORSESHOE, G.M.L. 4990z; whilst to the eastward of the railway line are the LUCKY HIT, G.M.L. 5137z, or LUCKY STRIKE, G.M.L. 5194z; the NEVER DESPAIR, G.M.L. 5225z; the BALLARAT MENZIES, G.M.L. 5113z; the JUST-IN-TIME, G.M.L. 4886z; the SOPHIA, G.M.L. 5233z; the BLACK AND WHITE, G.M.L. 4978z; the GUIDING STAR, G.M.L. 4951z; and the COLUMBIA, G.M.L. 5104z.

Table showing the Yield of Miscellaneous Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1904 ...	Olive Branch, G.M.L. 5112z	40·00	8·29	·20
1904 ...	Lincoln, G.M.L. 5134z	31·00	71·75	2·31
1904 ...	Lincoln, G.M.L. 5181z	37·00	59·17	1·54
1905 ...	Do. „	24·00	47·25	2·71
	Total	61·00	106·42	1·74
1901 ...	Lady Sarah, G.M.L. 5009z	40·00	48·17	1·20
1902 ...	Do. „	60·00	74·34	1·23
1903 ...	Do. „	38·00	5·46	·14
1904 ...	Lady Fanny, G.M.L. 5179z	16·00	10·09	·63
	Total	154·00	138·06	·89
1903 ...	Queenslander, G.M.L. 5126z	28·00	16·10	·57
1904 ...	Do. „	8·00	4·25	·53
	Total	36·00	20·35	·56
1904 ...	Two Walters, G.M.L. 5207z	30·00	10·78	·35
1905 ...	Do. „	50·00	20·00	·40
	Total	80·00	30·78	·38
1897 ...	Monte Christo and Gem, G.M.Ls. 3235z, 3398z	12·00	2·42	·20
1903 ...	Sailor, G.M.L. 5109z	...	·59	...
1903 ...	Bristol, G.M.L. 5116z	12·00	4·64	·38
1904 ...	Do. „	14·00	3·06	·22
1903 ...	Busy Bee, G.M.L. 5105z	46·00	20·87	·45
1904 ...	Do. „	161·00	59·90	·37
1904 ...	Adelaide, G.M.L. 5128z	109·00	52·02	·47
	Total	354·50	143·50	·40

Table showing the Yield of Miscellaneous Leases—continued.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1897 ...	Gem Extended, G.M.L. 4849z... ...	52 00	25·95	·49
1898 ...	Do. do. „	52·00	21·08	·40
1899 ...	Do. do. „	19·50	8·14	·42
1900 ...	Do. do. 4957z... ...	15·00	6·33	·42
1902 ...	Do. do. 5015z... ...	15·00	6 92	·46
1904 ...	Menzies Star, G.M.L. 5118z	94·00	55·68	·59
1905 ...	Do. do. „	20·00	6·41	·32
	Total	**267·50**	**130·51**	**·49**
1904 ...	Lucky Venture, G.M.L. 5151z ...	**45·00**	**9·49**	**·21**
1902 ...	Lord Nelson, G.M.L. 5021z	**12·00**	**4·55**	**·37**
1897 ...	Great Klondyke, G.M.L. 4853z ...	16·80	36·94	2·20
1903 ...	Klondyke, G.M.L. 5132z	16·00	6·33	·39
1904 ...	Do. „	15·00	2·04	·13
1905 ...	Do. „	52·00	11·72	·22
	Total	**83·00**	**20·09**	**·24**
1898 ...	Britannia, G.M.L. 4850z	**8·00**	**2·74**	**·34**
1901 ...	Hornet's Nest, G.M.L. 4998z	**5·00**	**1·68**	**·33**
1901 ...	Golden Horseshoe, G.M.L. 4990z ...	**20 00**	**7·31**	**·36**
1903 ...	Lucky Hit, G.M.L. 5137z	5·00	9·75	1·95
1904 ...	Do. „	35·00	5·49	·15
1904 ...	Lucky Strike, G.M.L. 5194z	36·00	5·10	·14
	Total	**76·00**	**20·34**	**·26**
1905 ...	Never Despair, G.M.L. 5225z	**81·00**	**42 10**	**·50**
1898 ...	Just in Time, G.M.L. 4886z	24·00	12·04	·50
1903 ...	Ballarat Menzies, G.M.L. 5113z ...	25·75	12·22	·47
1904 ...	Do. „ ...	39·00	5·84	·15
1904 ...	Just in Time, G.M.L. 5141z	25·00	4·08	·62
	Total	**113·75**	**34·18**	**·30**
1905 ...	Sophia, G.M.L. 5233z	**113·00**	**79·34**	**·70**
1901 ...	Black and White, G.M.L. 4978z ...	62·00	26·56	·44
1902 ...	Do. „ ...	20·00	9·00	·45
	Total	**82·00**	**35·56**	**·43**
1900 ...	Guiding Star, G.M.L. 4951z	48·00	33·74	·70
1901 ...	Do. „	200·35	220·92	1·11
1902 ...	Do. „	23·00	13·60	·59
1904 ...	Columbia, G.M.L. 5104	18·00	9·86	·55
	Total	**289·35**	**278·12**	**·93**

The Craig-y-nos, G.M.L. 5250, is situated upon the eastern side of the Railway Line and north of the township of Woolgar; it has repeatedly changed hands, but in no instance has it been held for long.

A considerable amount of developmental work was done upon it by the W.A. Venture Corporation, who held it in 1897, and who sank two shafts—one 100 feet, and one 150 feet—with 500 feet of drives. Owing to the fact that it has so often changed hands, no systematic work has been carried out, and in consequence no opinion as to the character of the lode can be formed.

Table showing the Yield of the Craig-y-nos Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.	Total.		Average rate per ton.
					Ore crushed.	Gold therefrom.	
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1897 ...	Nick of Time, G.M.L. 3205z	177·50	113·17	·63	117·50	113·17	·63
1898 ..	Athelstane, G.M.L. 4873z	362·00	171·77	·47			
1899 .	Do. ,,	96·00	32·73	·34	458·00	204·50	·45
1900 ...	Craig-y-nos, G.M.L. 4940z	318·00	264·61	·83			
1901 ..	Do. ,,	208·75	85·30	·40	527·25	349·91	·66
1902 ...	Perseverance, G.M.L. 5102z.	98·00	29·52	·30	98·00	29·52	·30
1903 ...	Craig-y-nos, G.M.L. 5220z	220·00	88·15	·40	220·00	88·15	·40
	Total	...	...	...	1,480·75	785·25	·53

The Menzies Gift, G.M.L. 3036z, and The Gift, G.M.L. 4916z, which adjoins it, are situated a little south of Woolgar, and mining was evidently started here on the strength of their position at the head of an alluvial run which extended from them to a little beyond the Telegraph line in a westerly direction. Of the latter there are no records nor returns, whilst the reefs worked proved of too low a grade to be payable. From the former of these 50·00 tons of stone were crushed, which yielded 12·74ozs. of gold, and from the latter 10·00 tons, which yielded 5·37ozs. of gold.

The Barunga Brave, G.M.L. 4691z, is situated about $2\frac{1}{2}$ miles south. It has not been worked since 1898, up to which date 23 tons of stone were crushed, which yielded 19·72ozs. of gold [**1185, 1189**].

The Black Horse, G.M.L. 5106z, and Storm King, G.M.L. 5176z, are situated upon a low ridge about one mile to the eastward of Woolgar. A small patch of alluvium was worked in a little gully crossing the former, which terminated at a small quartz vein which is now being worked.

Table showing the Yield of the Black Horse Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1903 ...	Black Horse, G.M.L. 5106z	...	22·79	...
1904 ...	Do. „	140·00	181·81	1·29
1905 ...	Do. „	76·00	45·71	·60
	Total	**216·00**	**250·31**	**1·16**

The Black Jack, G.M.L. 4879z, is situated to the southward of the last, being a portion of what was originally the Lady Main, and upon it four shafts have been sunk, the deepest being 187 feet, in which the water level is 170 feet from the surface. The reef varied from eight inches to three feet in width with six to eight feet of formation. The course of the shoot, which was 100 feet wide, is a little west of north with a southerly dip, but it dies out below the 130-feet level. The vein is of the lenticular type, and decreases in size and value with depth.

Table showing the Yield of the Black Jack Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1897 ...	Lady Main, G.M.L. 3963z	95·00	112·65	1·19
1898 ...	Black Jack, G.M.L. 4879z	50·00	94·79	1·89
1899 ...	Do. „	190·00	314·42	1·65
1900 ...	Do. „	306·00	470·00	1·54
1901 ...	Do. „	113·00	99·54	·88
1902 ...	Do. „	120·00	62·74	·52
1903 ...	Do. „	10·00	9·60	·96
1904 ...	Do. „	150·00	35·60	·24
1905 ...	Do. „	12·00	9·28	·77
	Total	**1,056·00**	**1,209·18**	**1·14**

The Lone Hand, G.M.L. 5230z, lies a little west of the latter, and from it 37 tons of stone yielded 34·47 ounces of gold.

The Menzies Consolidated Gold Mine, Ltd.—This Company own a number of leases situated upon the western side of the railway line close to the township of Woolgar.

The main workings are situated upon the Princess May South, G.M.L. 4935z, but extend northward into the Princess May, G.M.L. 4934z. The line of reef, however, has been traced in a north-west direction for over 1,000 feet into the Princess Eva, G.M.L. 931z, where another series of old workings are located. On the

WINZE
WINZE
JD

The Hon: H. Gregory, M.L.A.
Minister for Mines.

PLAN & SECTIONS
OF
THE PRINCESS MAY & PRINCESS MAY STH

G.M.L 4934 G.M.L 4935

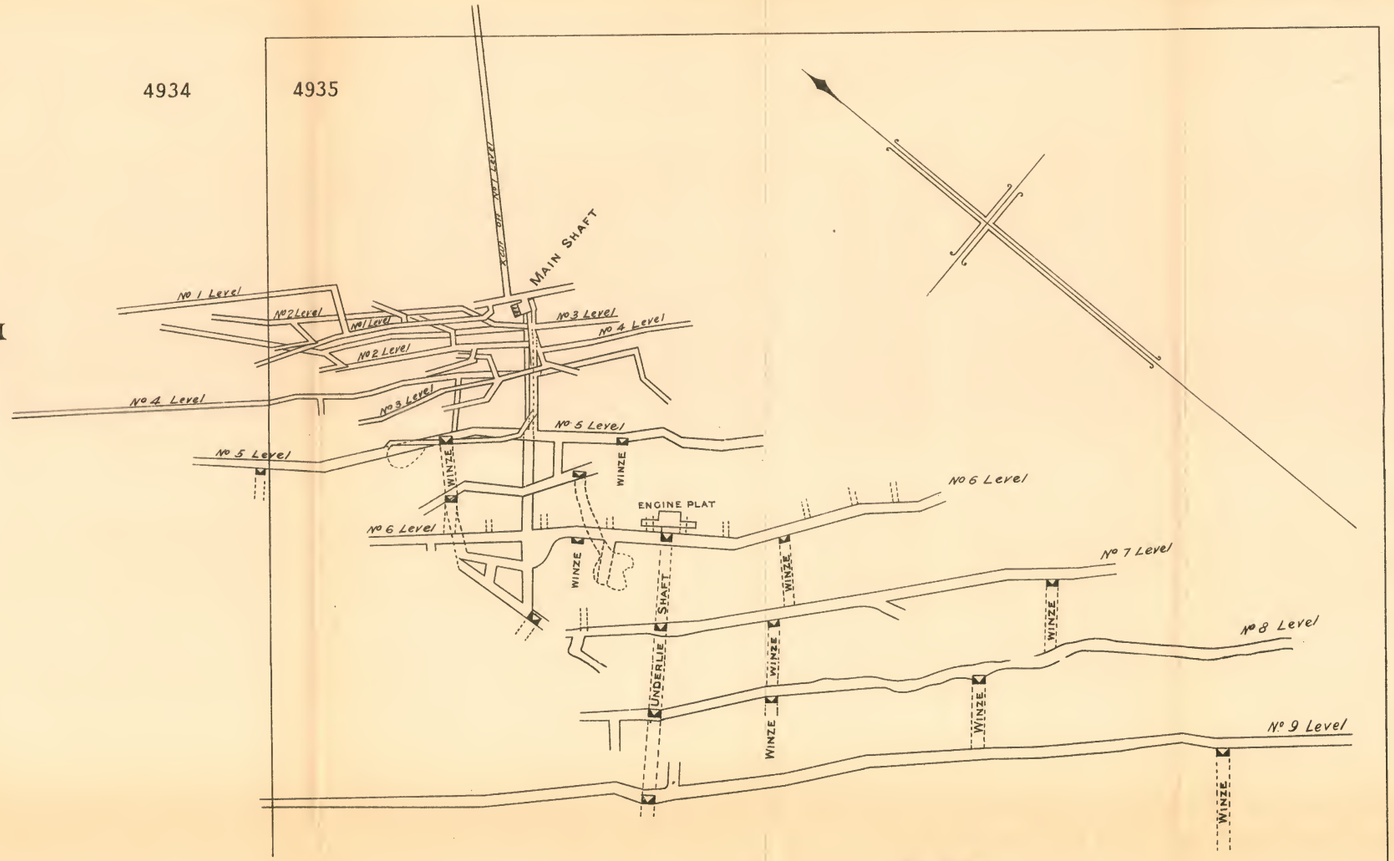
MENZIES CONSOLIDATED G.MsLTD.

N. COOLGARDIE G.F.

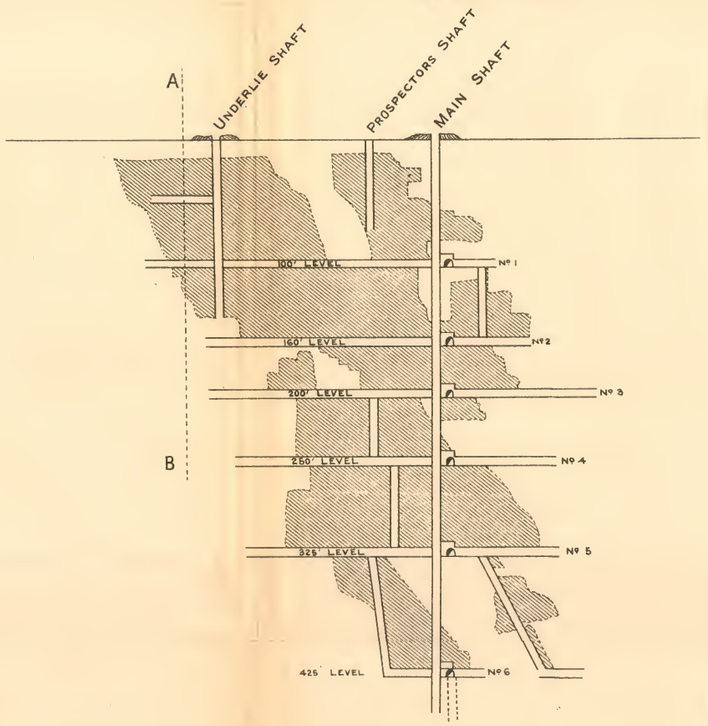
Scale of Feet.

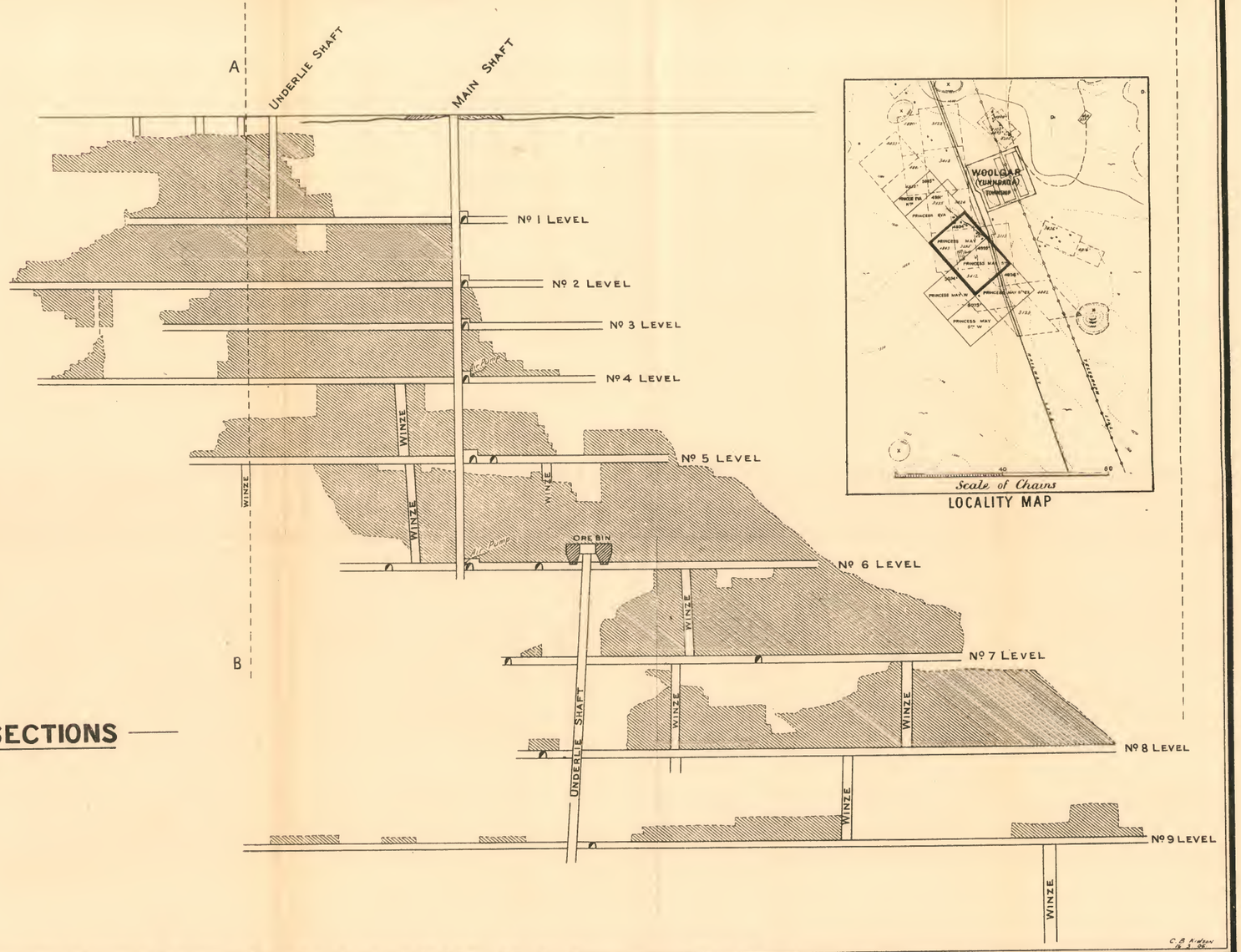
0 100 200 300 400

Note — Stoped .....



— PLAN —





— LONGITUDINAL SECTIONS —

LOCALITY MAP

A. Gibb Maitland
Government Geologist.

C.B. Nelson 9.1.06

H.J. Pether, Government Lithographer, Perth, W.A.

Princess May South, a main shaft has been sunk to a depth of 425 feet, which cuts the reef between the No. 1 and No. 2 levels, below which crosscuts connect it with the various levels, the No. 5 level at the bottom being 170 feet distant. Owing to the distance from the lode being so great, the shaft was not continued, but a main haulage winze carried down from the No. 5 at a point about 100 feet further south, by means of which the mine was worked to the No. 9 or 688-feet level, but since the ore-shoot had dipped to the southward of this, another winze has been sunk still further south from the bottom level, which has now reached a vertical depth below the surface of over 800 feet; this is therefore considerably the deepest mine in Menzies. (Plate VI.)

The ore in this mine has proved in the nine levels to average about 400 feet in horizontal length with a dip of about 36 degrees south upon the plane of the lode, which dips 57 degrees south-west, the total length of the proved ore-shoot from the surface to the bottom of the mine being over 1,600 feet, whilst the thickness is so variable that it is impossible to state it but it must average three feet.

The lode is clearly of the true fissure type having an extremely well-defined and striated footwall, whilst the hanging wall is more or less broken by feeders. In the levels above No. 6 a parallel lode has been worked which had a strike more to the westward, this, however, took a turn between Nos. 5 and 6 more to the northward than the main ore body with which it would appear to junction further north. The main ore-shoot in this mine appears if anything to gain in width and definition with depth, whilst in the north drive at the No. 9 level, the vein was found to continue and carry gold for a distance of over 800 feet, it being poor near the winze but improves towards the end. This may be another shoot or the continuation of one that was prospected at the surface farther north.

At the bottom of the winze the lode is highly mineralised, carrying large quantities of Pyrrhotite (magnetic pyrites) [6314] whilst the gold value still keeps up, the vein being over six feet in thickness and as well defined as at any part of the mine.

In the northern workings upon the Princess Eva a main shaft has been sunk and the lode worked to a depth of over 200 feet, but owing to very considerable faulting these workings were abandoned and the shaft is now used as a water shaft.

Water containing 2·8 per cent. of solid matter was cut at a depth of 130 feet, which yielded originally 30,000 gallons per diem this, however, has considerably diminished whilst after passing through the zone of saturation, the formation is practically dry. [1647-52.]

Table showing the Yield of the Menzies Consolidated Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1897 ...	Princess May and Princess May South, G.M.Ls. 4934z and 4935z ...	6,525·0	5,456·13	·83
1898 ...	Do. do. ...	6,969·0	5,702·80	·82
1899 ..	Do. do. ...	7,617·0	6,978·04	·92
1900 ...	Do. do. ...	6,589·0	5,936·89	·90
1901 ...	Do. do. ...	10,489·0	6,817·49	·65
1902 ...	Do. do. ...	12,795·0	7,535·36	·59
1903 ...	Do. do. ...	16,096·0	8,341·31	·52
1904 ...	Do. do. ...	14,657·0	8,972·58	·61
1905 ...	Do. do. ...	17,634·0	10,134·44	·59
	Total	99,371·0	65.875·05	·66

The Goodenough, G.M.L. 4855z, is situated about three miles in an east-north-east direction from Menzies, and lies at the extreme north of the Kensington Group; it has recently been acquired by the Queensland Menzies G.M. Co., N.L.

A line of lode can be traced at the surface in an east and west direction for a distance of about 600 feet lying parallel to an outcrop of sericite schist, which is apparently a dyke, whilst to the south it dips into a solid diorite hill. [6337, 6340, 6364.]

Five underlay shafts, the deepest of which is 240 feet, have been sunk upon this lode, which dips at an angle of from 25 to 30 degrees south. Levels have been driven at the 100 feet (55 feet vertically below the surface) and 180 feet (80 feet vertical depth, or at the water-level) upon a body of stone varying from three to six feet in thickness. A dislocation in the lode was met with in the 100-feet level a little north of the No. 2 shaft, beyond which a branch vein appears to have been followed. The main lode however was picked up to the northward and opened upon near the mouth of the No. 1 shaft by means of first an opencut and then a winze which was carried down to the 100-feet level.

In the opencut the reef is large and solid, and yielded very good returns, but suddenly came to an end upon what is probably a fault; but it is too near the surface to determine this point with any degree of certainty.

This lode is very highly ferruginous in places, being literally one mass of pyrites, whilst specimens of chloride of silver have also been met with.

All the developments so far have been carried on in the oxidised zone, where the rock is soft and of a yellow argillaceous nature; in consequence it affords little evidence as to its original character. So far the stone crushed has been of good quality, but the gold is of very low value.

There is a good supply of fresh water in a well a little north of the outcrop said to have yielded 2,000 gallons per diem, whilst the water in the mine makes at the rate of about 600 gallons.

Table showing the Yield of the Goodenough Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1897 ...	Goodenough, G.M.L. 4855z	125·00	104·32	·83
1898 ...	Do. „	167·50	264·11	1·57
1899 ...	Do. „	390·55	564·34	1·44
1900 ...	Do. „	322·50	380·05	1·17
1901 ...	Do. „	852·40	1,314·33	1·55
1902 ...	Do. „	694·00	1,671·57	2·40
1903 ...	Do. „	518·00	603·05	1·16
1904 ...	Do. „	361·00	276·09	·76
1905 ...	Do. „	1,017·00	1,042·80	1·02
	Total	**4,447·95**	**6,220·66**	**1·39**

To the eastward and southward of the Goodenough are the following leases, upon which little work has been done:—

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1898 ...	Golden Shoe, G.M.L. 4861z	**44·00**	**51·36**	**1·17**
1902 ...	Coronation, G.M.L. 5041z	**10·00**	**8·39**	**·84**
1905 ...	Little Vic or Anti Daglish, G.M.L. 5225z	**17·50**	**29·73**	**1·70**

Miscellaneous Leases.

On the Four o'Clock, G.M.L. 5072z, which lies to the south-west, a small reef with a north-east south-west course and dipping south-east has been worked to a shallow depth for a length of five chains, whilst on the Resurgam, G.M.L. 5117z, which apparently lies upon the same line, the reef has been traced for a length of

10 chains but has only been worked for a length of 80 feet and to a depth of 30 feet, the average size being three inches.

Table showing the Yield of the Four o'Clock and Resurgam Reefs.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons	ozs.	ozs.
1901 ...	Four o'Clock, G.M.L. 5012z	10·00	10·90	1·09
1902 ...	Do. „	45·00	20·41	·45
1902 ...	Do. 5072z	18·00	20·23	1·12
1903 ...	Do. „	35·00	45·71	1·30
1904 ...	Do. „	20·00	4·00	·20
	Total	**128·00**	**101·25**	**·79**
1902 ...	Resurgam, G.M.L. 5076z	10·00	9·02	·90
1903 ...	Do. „	11·00	20·67	1·88
1903 ...	Do. 5117z	10·00	4·68	·46
1904 ...	Do. „	5·00	4·74	·95
	Total	**36·00**	**39·11**	**1·09**

To the eastward of the last and south of the Goodenough are Brown Hill, G.M.L. 4949z, the Rising Sun, G.M.L. 5040z, and Christmas Gift, G.M.L. 5016z; whilst the Danae, G.M.L. 5050z, and Blaas Reward, G.M.L. 5025z, lie to the south-west on the flat, and the Industria, G.M.L. 4899z, south along the range.

Table showing the Yield of Miscellaneous Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1900 ...	Brown Hill, G.M.L. 4049z	15·00	9·19	·57
1901 ..	Do. „	16·00	5·72	·39
	Total	**31·00**	**14·91**	**·48**
1902 ...	Rising Sun, G.M.L. 5040z	**10·00**	**10·03**	**1·00**
1902 ...	Christmas Gift, G.M.L. 5016z ...	**93·00**	**83·86**	**·90**
1902 ...	Blaas Reward, G.M.L. 5025z	**23·00**	**17·64**	**·77**
1902 ...	Danae, G.M.L. 5050z	**10·00**	**3·89**	**·38**
1899 ...	Industria, G.M.L. 4899z	**44·80**	**14·94**	**·34**

The True Blue, G.M.L. 3822z, now known as the Picton, G.M.L. 4985z, was worked from 1899 to 1901 by the W.A. Proprietary Company, who in sinking a main shaft struck a supply of 1,300 gallons per diem of fresh water at a time when water was particularly scarce in Menzies. Several shafts have been sunk upon this property in which a large low-grade formation was cut which strikes in a north-east and south-west direction, dipping at a low angle to the south-east, but of this only the quartz-veins in the upper levels have been worked.

Table showing the Yield of the Picton Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1899 ...	True Blue, G.M.L. 3322z	100·00	24·05	·24
1901 ...	Do. „	56·00	14·59	·26
1901 ...	Picton, G.M.L. 4985z	50·00	19·94	·40
1904 ...	Do. „	177·50	51·61	·40
1905 ...	Do. „	143·00	27·52	·19
	Total	526·50	137·71	·26

Between the Picton and the Kensington there have been a number of leases which have been worked upon a series of lenticular quartz-veins which strike north-east and dip south-east. These start with the True Blue South, G.M.L. 4923z, which later on was called the Lord Roberts, G.M.L. 5168z, in which a body of stone four feet wide was worked for a length of 200 feet and to a depth of from 40 to 50 feet.

Table showing the Yield of the True Blue South Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1899 ...	True Blue South, G.M.L. 4923z ...	44·00	22·48	·51
1900 ...	Do. „ ...	7·00	31·93	4·56
1901 ...	Lord Roberts, G.M.L. 5007z	39·00	27·40	·70
1902 ...	Do. „	30·00	10·69	·35
1903 ...	Do. 5168z	26·00	7·06	·27
	Total	146·00	99·56	·68

The Kensington Vindicator, G.M.L. 3615z, was originally worked as a whole by a Company, but later the northern portion was taken up as the Alexandra, G.M.L. 4918z, and later on as the

Butterfly, G.M.L. 4992z. On this ground a lode has been worked for a length of 200 feet, the quartz averaging about 12 inches down to the 50-feet level. A shaft has been sunk to a depth of 135 feet, which cut a supply of stock water yielding about 50 gallons per diem.

Table showing the Yield of the Butterfly Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1898 ...	Kensington Vindicator, G.M.L. 3615z	26·00	45·60	1·75
1899 ...	Do. „	7·00	2·10	·30
1899 ...	Alexandra, G.M.L. 4918z	15·00	19·24	1·28
1900 ...	Do. „	82·00	136·52	1·90
1901 ...	Do. „	6·00	16·13	2·69
1901 ...	Butterfly, G.M.L. 4992z	25·00	54·96	2·19
1902 ...	Do. „	33·00	72·07	2·19
1903 ...	Do. „	16·00	29·24	1·82
1904 ...	Do. „	23·50	10·93	·47
	Total	**233·50**	**386·79**	**1·65**

Upon the southern portion of this, which was afterwards called the Vindicator South, G.M.L. 4924z, and later the Little Tom, G.M.L. 5083z, a small vein of stone about 8 inches wide has been opened up to a depth of 60 feet. This vein on its southward course gradually loses its easterly dip, turning flat with a slight southerly dip, then tilting over to the west.

Table showing the Yield of the Little Tom Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1899 ...	Vindicator South, G.M.L. 4924z ...	9·00	7·56	·84
1900 ...	Do. „ ...	20·00	25·27	1·26
1902 ...	Little Tom, G.M.L. 5083z	7·00	12·51	1·79
1903 ...	Do. „	18·00	27·98	1·55
	Total	**54·00**	**73·32**	**1·35**

Upon the Menzies Kensington, G.M.L. 3277z, which adjoins the last, to judge from the large cavern-like excavation a large lenticular body of quartz with a southerly dip was worked, the extension of which has not been cut in any of the shafts either to the dip or on the strike. A number of vertical shafts have been

sunk, one 125 feet (which is the water-level), and another 100 feet, whilst an underlay has been sunk 70 feet and 400 feet of driving, but in these no stone of any value was cut.

Table showing the Yield of the Kensington Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1897 ...	Menzies Kensington, G.M.L. 3277z ...	466·00	408·97	·87
1898 ...	Do. „ ...	327·00	217·68	·66
1899 ...	Do. „ ...	135·00	133·06	·98
1900 ...	Do. „ ...	..	23·32	...
1901 ...	Kensington, G.M.L. 3277z	33·00	83·99	2·54
1902 ...	Do. „	...	...	...
1903 ...	Do. „	102·00	21·20	·21
1904 ...	Do. „	10·00	5·19	·51
	Total	**145·00**	**110·38**	**·83**

The True Blue, G.M.L. 5130z, is situated a little to the eastward of the Kensington line and south of the Picton, and in it a small vein of rich quartz has been traced for a length of 400 feet at a depth of 40 feet from the surface.

Table showing the Yield from the True Blue Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons	ozs.	ozs.
1903 ...	True Blue, G.M.L. 5130z	22·00	42·02	1·21
1904 ...	Do. „	57·00	128·40	2·25
1905 ...	Do. „	18·00	16·35	·90
	Total	**97·00**	**186·77**	**1·92**

Farther east still upon the western side of Mt. Misery are two old leases which have covered the same ground called respectively the Picton Valley, G.M.L. 4890z, and the Lady Min, G.M.L. 4917z. The reef is small but well defined, striking north-east and dipping south-east, and can be traced into the Maranora, which appears to be the southern extension of it.

The workings consist of two groups of shallow underlay shafts in which apparently some 3 or 4 inches of the hanging-wall side has been worked to a depth of 20 feet.

Table showing the Yield of the Lady Min Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons	ozs.	ozs.
1898 ...	Picton Valley, G.M.L. 4890z	10·00	21·51	2·15
1899 ...	Do. ,, ...	10·00	14·31	1·43
1899 ...	Lady Min, G.M.L. 4917z	5·00	9·91	1·98
1900 ...	Do. ,, ...	10·00	46·37	4·63
	Total	**35·00**	**92·10**	**2·63**

The Old Hidden Treasure, G.M.L. 4750z, is now being worked as the Maranora, G.M.L. 4895z, and in it a reef dipping at an angle of 80 degrees south-east which, varying from a few inches to seven feet in thickness, has been opened up to a depth of 140 feet by a level 300 feet in length, the course of which is 21 degrees east of north. The shaft has been continued to a depth of 198 feet, a small supply of stock water being cut at 150 feet.

The reef is enclosed in a formation carrying a little gold, the thickness of which has not yet been tested.

The character of this reef cannot be determined at the only level accessible, but it presents many indications of being of the fissure type; this is further supported by its length of outcrop [**1053**].

Table showing the Yield of the Maranora Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs..	ozs.
1898 ...	Hidden Treasure, G.M.L. 4750z ...	10·00	5·20	·52
1899 ...	Maranora, G.M.L. 4895z	278·30	281·65	1·01
1900 ...	Do. ,, ...	307·00	402·30	1·31
1901 ...	Do. ,, ...	223·00	216·50	·97
1902 ...	Do. ,, ...	215·00	226·04	1·05
1903 ...	Do. ,, ...	272·00	292·63	1·07
1904 ...	Do. ,, ...	286·00	236·25	·83
1905 ...	Do. ,, ...	454·00	479·78	1·17
	Total	**2,035·50**	**2,135·15**	**1·04**

To the southward of the last are a group of old leases which have covered more or less the same ground; these consist of the Kensington Easter Gift, G.M.L. 5103z, Prince Albert, G.M.L. 4926z, West Sea, G.M.L. 4908z, and Moonlight, G.M.L. 5183z. On these a small reef, from five to six inches in width, dipping to the westward, has been opened up to a depth of 60 feet and worked for a length of five chains.

Table showing the Yield from sundry Leases.

Year.	Name and Number of Leases.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1903 ...	Kensington Easter Gift, G.M.L. 5103z	13·00	19·97	1·46
1904 ...	Do. ,,	4·00	3·45	·86
	Total	**17·00**	**23·42**	**1·38**
1899 ...	West Sea, G.M.L. 4908z	12·00	7·43	·62
1899 ...	Prince Albert, G.M.L. 4926z	6·00	4·91	·82
1900 ...	Do. ,, ...	15·00	6·43	·43
1904 ...	Moonlight, G.M.L. 5183z	35·00	25·71	·73
	Total	**68·00**	**44·48**	**·65**

To the eastward of the last, another line has been worked as the Brilliant, G.M.L. 5184z, the Kensington Sunday Gift, G.M.L. 4819z, or Sunday Gift, G.M.L. 5010z, and the Menzies Luxemberg, G.M.L. 5043z. The reef here strikes north and south and dips west, being two to six feet thick in the Brilliant; on the Sunday Gift it has been sunk on to a depth of 80 feet, and is about 12 inches in thickness, whilst in the Luxemberg the stone is small, but it has been worked for a length of 100 feet, to a depth of 40 feet, where the hard rock comes in. This vein at its north end is very flat, but generally dips steeper towards the south end.

Table showing the Yield of sundry Leases.

Year.	Name and Number of Leases.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1899 ...	Brilliant, G.M.L. 4911z	13.00	8·45	·65
1904 ...	Brilliant, G.M.L. 5184z	12·00	3·41	·28
1905 ...	Do. ,, ...	14·00	2·20	·16
	Total	**39·00**	**14·06**	**·38**
1896 ...	Kensington Sunday Gift, G.M.L. 4819z	26·00	27·81	1·07
1901 ...	Sunday Gift, G.M.L. 5010z	16·00	50·64	3·16
1902 ...	Do. ,, ...	72·30	197·59	2·74
1903 ...	Do. ,, ...	57·00	140·55	2 46
1904 ...	Do. ,, ...	68·00	65·59	·96
1905 ...	Do. ,, ...	88·00	89·32	1·02
	Total	**353·00**	**599·31**	**1·79**
1902 ...	Menzies Luxemberg, G.M.L. 5043z ...	**6·00**	**5·02**	**·83**

The Viking, G.M.L. 5038z, is a line further east still, and upon it a vein of stone, which runs in pipes varying from six to 12 inches

in thickness, has been worked for a length of 200 feet, the deepest shaft being 70 feet.

Table showing the Yield of the Viking Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1902 ...	Viking, G.M.L. 5038z	30·00	137·59	4·58
1903 ...	Do. „	21·00	81·36	3·87
1904 ...	Do. „	18·00	112·05	6·22
1905 ...	Do. „	21·00	83·99	3·99
	Total	**90·00**	**414·99**	**4·61**

About $2\frac{1}{2}$ miles south of the Kensington Group are one or two leases situated at what is known as Springfield, from the first property taken up upon which a good supply of fresh water was obtained.

Springfield, G.M.L. 4950z.—On this lease a flat lode dipping south has been worked for the the past five years by a number of shallow vertical shafts and surface working. It has not proved so far to continue of value in depth nor to extend east or west.

A vertical shaft has also been sunk to a depth of 130 feet in which a supply of 1,500 gallons per diem of fresh water was struck.

Table showing the Yield of the Springfield Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1900 ...	Springfield, G.M.L. 4950z	39·00	25·11	·64
1902 ...	Do. „	209·00	183·14	·87
1903 ...	Do. „	115·00	88·79	·77
1904 ...	Do. „	279·00	176·77	·63
1905 ...	Do. „	145·00	110·00	·76
	Total	**787·00**	**583·81**	**·74**

A little north of this some old shafts on the flat indicate what was the Blow Fly, G.M.L. 4964z, but this was only worked a short time and was never surveyed. From this lease 50·00 tons of stone were crushed, which yielded 32·29 ounces of gold.

South of Springfield is a lease called the Emu, G.M.L. 5164z, upon which a small reef which dips west is being worked, but little has been done on it as yet.

This lease was originally called the Myrtle, G.M.L. 5082z, but the workings then consisted of some shallow shafts on a quartz reef on the hill to the westward.

Table showing the Yield of the Emu Reef.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1903 ...	Myrtle, G.M.L. 5082z	56·00	57·94	1·03
1903 ...	Emu, G.M.L. 5144z	35·00	118·70	3·39
1904 ...	Do. 5164z	118·00	277·29	2·35
1905 ...	Do. „	177·00	417·95	2·36
	Total	**386·00**	**871·88**	**2·26**

The KURRAJONG, G.M.L. 3482z, FULCRUM, G.M.L. 5202z, and HOPEFUL, G.M.L. 5206z, lie about one and a half miles east of Mt. Misery. The first mentioned was only worked for a short time in the early days of the goldfield upon a small diorite outcrop, whilst the latter two were two small recent holdings upon patchy barren looking veins in the granite, near which some specks of gold had been discovered.

Table showing the Yield of sundry Leases.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1896 ...	Kurrajong, G.M.L. 3482z	**5·00**	**9·29**	**1·86**
1898	Federal, G.M.L. 4885z	44·00	51·41	1·16
1905 ...	Fulcrum, G.M.L. 5202z	12·00	11·02	·92
	Total	**56·00**	**62·43**	**1·11**
1904 ...	Hopeful, G.M.L. 5206z	12·00	22 51	1·87
1904 ...	Do. „	6·00	5·37	·89
	Total	**18·00**	**27·88**	**1·54**

SUNDRY CLAIMS.

Under this head an item appears annually in the returns, with the exception of 1903, as follow:—

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1897	18·00	9·02	·50
1898	118·75	140·87	1·19
1899	231·25	235·04	1·01
1900	179·00	155·42	·87
1901	63·00	65·20	1·03
1902	625·00	842·04	1·34
1904	358·00	385·56	1·08
1905	927·00	597·61	·64
Total ...	**1,910·00**	**1,721·46**	**·90**

Section III.—Conclusion.

In order to make the occurrence of the typical Menzies lode as clear as possible (the segregation, not the fissure veins, are here referred to) a brief *résumé* of their occurrence will be given.

It will have been noted from the foregoing description of the various mines in which segregation veins were worked that the formations downwards may be divided into three zones:—1st, the upper, which extends down to the water level, in which oxidation has taken place; this zone is of variable extent even in reefs situated in close proximity, and is not entirely governed by surface configuration. 2nd, the belt of water-bearing rock or zone of saturation, the limit of which in depth is governed by the permeable nature of the formation, and may, as in the case of the Shenton Reef, be entirely absent owing to local conditions, such as an impervious laterite covering which has prevented the down flow of meteoric waters, whilst a few chains west, in sinking the main shaft, a considerable supply of water was cut which has now risen through the connecting workings and flooded the workings which were previously dry; and 3rd, below the zone of saturation, when the country rock is massive and dry, being practically impervious to the overlaying water.

In the oxidised zone the rocks are usually soft near the surface, being highly weathered, consisting of yellow argillaceous and magnesian nature, passing imperceptibly into more or less weathered serpentine and chloritic schists. In this zone numerous lines of auriferous lodes are met with; they are of the composite order, consisting of a series of lenticular quartz veins or pipes which follow the rock foliation.

These veins may lie in a single line, one lens forming at or near the terminal point of the other, or, as is more commonly the case, overlapping one another, each following vein lying upon a parallel line of foliation. The lode body may be composed of a series of these parallel veins so arranged that the entire mass assumes a more or less lenticular form, *i.e.*, increasing in thickness towards the centre and diminishing towards the ends along the line of strike. Near the surface an enclosing zone of enriched decomposed rock is not infrequently met with which is termed "formation."

Below the water level the lode changes considerably in character, the ore body becoming a sulphide lode, and consists of definite shoots and blanks; the shoots appear as a general rule to cut out upon coming in contact with the solid country, or to penetrate it for only a short distance.

Below the terminal point of these shoots considerable prospecting has been done, but so far no vein encountered has proved of sufficient value to be worth working.

Owing to the fact that the surface of the auriferous belt is for the most part covered by superficial deposits, the reefs do not as a rule outcrop, but to judge from the mode of occurrence of those already discovered, it is probable that numerous others exist, and when it is noted that a very large area in the very heart of the belt has been scarcely prospected it is quite possible that even large and rich lodes may yet be discovered.

Since the erection of the State Battery the working miners have been enabled to profitably work many of the small but rich veins of stone which the companies had abandoned, and the return from this source alone is responsible for a very considerable proportion of the annual gold production of the district; in fact, without it, since the closing down of so many large mines, the district would have retrograded considerably.

Table showing the Return of the Ore treated at the Menzies State Battery.

Year.	Ore treated.	Gold therefrom.	Rate per ton.
	tons.	oz.	oz.
1904	5,067	7,508	1·48
1905	4,138	5,502	1·33
Total	**9,202**	**13,010**	**1·41**

The opening up of small veins in old workings has led to further prospecting, which has in many instances been amply rewarded by the discovery of other lines. This leads to the conclusion that in the main Menzies belt beneath the alluvium a large series of parallel lines of veins very probably exist, and should this prove to be the case, although the larger lodes may be worked out, this district may reasonably look forward to a very considerable and prosperous future.

Appendix I.

Synoptical Table showing the Yield of the Leases at Menzies up to the end of 1905.

NOTES.—(1.) Leases having the same name but are situated in different localities.
(2.) Leases with the same name covering a portion of the same ground.

Name of Lease or Company.	Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
Ada Ella	5185z	10·00	5·53	·55
Adelaide (1)	3378z	13·50	17·14	1·27
Do. (1)	5128z	109·50	52·02	·47
Africander (2)	3034z	189·00	250·42	1·32
Do. (2)	4984z	47·00	56·34	1·19
Do. (2)	5253z	34·50	38·09	1·10
Alexandra	4918z	103·00	171·89	1·67
Ancient Briton Extended	4007z	26·00	20·79	·78
Anti-Daglish	5225z	10·00	17·76	1·77
Athelstane	4873z	458·00	204·50	·45
Baden Powell (2)	5089z	17·00	18·20	1·07
Do. (2)	5241z	146·00	212·63	1·45
Ballarat Menzies	5113z	64·75	18·06	·28
Barunga Brave	4691z	23·00	19·72	·86
Battler's Rest	5143z	21·00	18·03	·86
Bellinger	5114z	31·00	9·02	·29
Blaas Reward	5026z	23·00	17·64	·77
Black Horse	5106z	216·00	250·31	1·16
Black Jack	4879z	961·00	1,096·53	1·14
Black and White	4978z	82·00	35·56	·43
Blow Fly	4954z	50·00	32·29	·65
Brilliant (2)	4911z	13·00	8·45	·65
Do. (2)	5184z	26·00	5·61	·21
Bristol	5116z	26·00	7·70	·30
Britannia	4850z	8·00	2·74	·34
Broken Seal	5022z	35·09	25·66	·73
Brown Hill	4949z	31·00	14·91	·48
Busy Bee	5105z	207·00	80·77	·39
Butterfly	4992z	97·50	167·20	1·71
Central Menzies	2834z	19·00	18·15	·95
Christmas Gift	5016z	93·00	83·86	·90
Columbia	5104z	18·00	9·86	·55
Coronation	5041z	10·00	8·39	·84
Coronation Gift	5064z	29·00	22·25	·77
Cosmopolitan	4961z	52·00	23·71	·45
Craig-y-Nos (2)	4940z	527·25	349·91	·66
Do. (2)	5220z	220·00	88·15	·40
Crown Cross (2)	4860z	234·00	181·66	·77

APPENDIX I.—*Synoptical Table showing the Yield of the Leases at Menzies up to the end of 1905*—continued.

Name of Lease or Company.	Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
Crown Cross (2)	4912z }	594·50	1,485·03	2·49
Do. (2)	4967z ,			
Do. South Extended	4979z	101·00	498·01	4·53
Crusoe Gold Claims, Ltd.	2823z, 3009z, 5017z, & 5018z	30,254·00	29,895·11	0·99
Daisy Bell	4061z	72·00	69·34	·96
Danae...	5050z	10·00	3·89	·39
Double Event	5135z	74·00	61·20	·83
Dublin Castle (2)	4952z	274·00	503·18	1·83
Do. (2)	5215z	141·00	230·38	1·63
Easter Gift	5095z	23·00	5·66	·24
Emu (2)	5144z	35·00	118·70	3·39
Do. (2)	5164z	295·00	695·24	2·35
Etrenna and Aurelia ...	4965z & 4966z	224·25	221·24	·98
European	5210z	8·00	5·25	·65
Federal	4885z	44·00	51·41	1·17
Federation	4959z	30·00	13·19	·43
Florence	2821z	6,664·00	6,354·88	·95
Flying Fish Leases	4982z & 4991z	209·50	730·66	3·48
Flying Fish	5089z	699·00	1,261·32	1·80
Four o'clock (2)	5012z	55·00	31·31	·57
Do. (2)	5072z	73·00	69·94	·96
Freeman	5039z	30·00	20·75	·69
Fulcrum	5202z	12·00	11·02	·92
Gem Extended (2)	4849z	123·50	55·17	·45
Do. (2)	4957z	15·00	6·33	·42
Do. (2)	5015z	15·00	6·92	·46
Gift	4916z	10·00	5·37	·54
Golden Age (2)	5005z	76·00	41·09	·54
Do. (2)	5092z	47·00	54·85	1·17
Golden Butterfly	4997z	120·00	36·37	·30
Golden Crown	4973z	16·00	35·42	8·21
Golden Horseshoe	4990z	20·00	7·31	·36
Golden Shoe	4861z	44·00	51·36	1·17
Golden Star	4907z	19·00	14·13	·74
Goodenough	4855z	4447·95	6220·66	1·39
Great Hope	5090z	12·50	21·85	1·74
Great Klondyke	4853z	16·80	36·94	2·20
Guiding Star	4951z	271·35	268·26	·99
Hayles and Taverstock ...	5000z	84·00	107·15	1·27
Heart's Content	4947z	44·00	82·37	1·87
Home Signal	4993z	5·00	4·94	·98

APPENDIX I.—*Synoptical Table showing the Yield of the Leases at Menzies up to the end of 1905*—continued.

Name of Lease or Company.	Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
Homeward Bound	5173z	33·00	4·82	·14
Hornet's Nest	4998z	5·00	1·68	·33
Hopeful	5206z	18·00	27·88	1·54
Horseshoe	5045z	43·00	13·74	·31
Indus	4291z	16·00	2·76	·17
Industria	4899z	44·00	14·94	·34
Ivy	4942z	15·00	1·58	·10
Jimgellie	4878z	42·00	28·78	·68
Just-in-time (2)	4886z	24·00	12·04	·50
Do. (2)	5141z	25·00	4·08	·62
Kensington	3277z	145·00	110·38	·84
Kensington Easter Gift ...	5103z	17·00	23·42	1·38
Kensington Sunday Gift ...	4819z	26·00	27·81	1·07
Kensington Vindicator ...	3615z	33·00	47·70	1·44
Klondyke (2)	5131z	16·80	36·94	2·20
Do. (2)	5156z	16·00	6·33	·39
Do. (2)	5226z	52·00	11·72	·22
Kurrajong	3482z	5·00	9·29	1·86
Lady Fanny	5179z	16·00	10·09	·63
Lady Harriet	2822z	759·00	645·45	·88
Lady Harriet Leases ...	4972z & 5002	2,177·00	2,023·38	·95
Lady Main	3963z	95·00	112·65	1·19
Lady Min	4917z	15·00	56·28	3·75
Lady Sarah	5009z	138·00	127·97	·92
Lady Shenton	2820z & 3006z	96,280·00	132,101·31	1·37
Lady Sherry	2838z	904·25	744·65	·82
Lincoln (1)	5134z	31·00	71·75	2·31
Do. (1)	5181z	61·00	106·42	1·74
Lion (2)	5069z	48·00	115·91	2·41
Do. (2)	5244z	43·00	56·70	1·32
Little Peter	5201z	10·00	3·41	·34
Little Tom	5083z	25·00	40·49	1·62
Little Vic	5225z	7·50	11·97	1·59
Little Wonder (2)	5139z	14·00	15·96	1·14
Do. (2)	5163z	94·00	329·98	3·51
Do. (2)	5189z	276·00	581·09	2·10
London and Coolgardie Explorers, Ltd. (2)	3116z & 3118z	340·00	394·23	1·12
London and Coolgardie Explorers, Ltd. (2)	5013z	43·00	60·75	1·39
Lone Hand	5230z	59·00	50·40	·85
Lord Nelson	5021z	12·00	4·55	·37
Lord Roberts (2)	5007z	69·00	38·09	·55
Do. (2)	5168z	26·00	7·06	·27

APPENDIX I.—*Synoptical Table showing the Yield of the Leases at Menzies up to the end of 1905*—continued.

Name of Lease or Company.	Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
Lucky Hit	5137z	40·00	15·24	·38
Lucky Prop	5127z	72·00	17·96	·24
Lucky Strike..	5194z	36·00	5·10	·14
Lucky Venture	5151z	45·00	9·49	·21
Maori (2)	4983z	64·00	80·72	1·26
Do.(2)	5196z	12·00	2·63	·22
Maori Gold Mine, Ltd. ...	3059z	571·00	654·06	1·11
Maori Chief (2)	4914z	303·00	218·41	·32
Do. (2)	4987z	543·00	474·68	·87
Maranora	4895z	2,035·30	2,135·15	1·04
McClay's Welcome	3744z	82·00	48·77	·59
Menzies, Limited ...	2826z, 2828z, 2829z, 3050z, 3051z, 3055z, and 3056z	308·00	457·23	1·49
Menzies Alpha Leases, Ltd.	3011z and 3031z	11,037·00	15,537·74	1·40
Menzies Consolidated Gold Mines, Ltd.	4931z, 4934z/6z	99,371·00	65,875·05	·66
Menzies Fortuna	5136z	137·00	139·74	1·09
Menzies Gift...	3036z	50·00	12·74	·26
Menzies Gold Estates, Ltd.	3042z, 3046z, and 3054z	431·00	149·90	·35
Menzies Gold Reefs Proprietary	2824z/5z and 2842z	6,063·00	11,293·59	1·86
Menzies Golden Age ...	2830z	292·50	1,059·00	3·62
Menzies Horseshoe	5145z	62·00	19·02	·30
Menzies Kensington ...	3277z	928·00	783·03	·84
Menzies Kensington East ...	4750z	10·00	5·20	·52
Menzies Lady Mary ...	3121z	14·00	1·22	·08
Menzies Lady Sherry ...	2835z	2,208·00	2,341·48	1·06
Menzies Luxemberg ...	5043z	6·00	5·02	·83
Menzies Main Reef (1) ...	4897z	39·00	15·98	·42
Do. (1) ...	5149z	37·00	10·00	·27
Menzies Mining and Exploration Corporation, Ltd.	3100z, 2832z, 2843z/4z, etc.	14,243·45	20,551·65	1·44
Menzies Pioneers	2822z	613·00	717·83	1·17
Menzies Proprietary (2) ...	4953z	129·25	162·69	1·25
Do. (2) ...	5140z	201·00	145·72	·72
Do. (2) ...	5236z	128·00	270·15	2·11
Menzies Star...	5118z	114·00	62·09	·54
Menzies United	3345z	139·00	96·09	·69
Menzies United, Ltd. ...	3151z	121·85	115·14	·94
Meriyulah	4960z	305·00	343·95	1·12
Moonlight	5183z	35·00	25·71	·73
Myrtle	5082z	56·00	57·94	1·03
Never Despair	5225z	81·00	42·10	·50
Nil Desperandum	4941z	87·00	195·77	2·25
Nugget	5209z	87·00	144·92	1·66

APPENDIX I.—*Synoptical Table showing the Yield of the Leases at Menzies up to the end of 1905*—continued.

Name of Lease or Company.	Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
Oceanic (2)	4920z	101·00	62·13	·61
Do. (2)	4969z	50·00	26·52	·53
Olive Branch	5112z	40·00	8·29	·20
Opal	5100z	30·00	4·71	·15
Ophir	5186z	17·00	5·92	·35
Ourine	4977z	30·00	22·83	·76
Perseverance	5102z	98·00	29·52	·30
Picton	4985z	370·50	99·07	·27
Picton Valley	4890z	20·00	35·82	1·79
Prince Albert	4926z	21·00	11·34	·54
Queenslander	5126z	36·00	20·35	·56
Queensland Menzies G.M. Co.	...	44,851·00	73,808·82	1·64
Rescue	5065z	48·00	79·06	1·68
Resurgam (2)	5076z	21·00	29·69	1·41
Do. (2)	5117z	15·00	9·42	·62
Resurrection	4859z	46·50	23·22	·50
Rising Sun	5040z	10·00	10·03	1·00
Sailor	5109z	...	·59	...
Secret	5232z	56·00	150·52	2·68
Sefton	5080z	8·10	12·66	1·56
Sentinal	5204z	55·00	35·58	·64
Sophia	5233z	113·00	79·34	·70
Springfield	4950z	787·00	583·81	·74
St. Albans (2)	4883z	403·75	687·09	1·70
Do. (2)	5081z	73·00	109·04	1·49
Success	4980z	120·00	114·09	·95
Sunday Gift	5010z	353·00	599·31	1·79
Surprise	5002z	123·00	116·24	·94
Three Battlers	4871z	57·00	40·09	·72
True Blue (1)	3322	100·00	24·05	·24
Do. (1)	5130	97·00	186·77	1·92
True Blue South	4923	51·00	54·41	1·06
Two Walters	5207z	80·00	30·78	·38
Union Jack	4889z	593·00	679·10	1·16
Victoria Cross	5131z	32·00	7·48	·23
Victory	5066z	239·00	533·63	2 23
Victory North	5068z	172 50	274·63	1·59

APPENDIX I.—*Synoptical Table showing the Yield of the Leases at Menzies up to the end of 1905*—continued

Name of Lease or Company.	Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
Victory South	5094z	287·00	311·81	1·08
Viking	5038z	90·00	414·99	4·61
Vindicator South	4924z	29·00	32·83	1·12
Wallaroo Menzies G.M. Co.	3235z & 3398z	12·00	2·42	·20
Warrior Menzies G.M. Co.	3048z	1,153·00	729·06	·63
Warrior	3048z	650·00	418·49	·64
Welcome	5101z	90·00	24·53	·27
West Sea	4908z	12·00	7·43	·62
W.A. Development Syndicate	3205z	177·50	113·17	·63
Westralia Menzies	5034z	20·00	32·56	1·14
Witch Hazel	5154z	21·00	8·82	·42
Sundry Claims	...	1,910·00	1,721·46	·90

Appendix II.

List of Specimens in the Geological Survey Museum from the Menzies District.

Registered Number of Specimen.	Registered Number of Micro-slide.	Name of Specimen.	Locality of Specimen.	Remarks.
750	...	Serpentine schist	Alpha, G.M.L. 3011z	
751	24	Mica schist	Warrior, G.M.L. 3048z	
752	...	Serpentine schist	Golden Age, G.M.L. 2830z	
753	...	Ironstone	G.M.L. 3478z	
754	23	Hornblend schist	Alpha, G.M.L. 3011z	
755	...	Mica schist	Warrior, G.M.L. 3048z	
756	...	Lode stuff	Shenton North, G.M.L. 2826z	
757	...	Mica schist	Occidental, G.M.L. 3340z	
758	...	Weathered diorite	do. do.	
785	...	Quartzite	Marie, G.M.L. 4576z	
786	...	Ferruginous quartzite	do. do.	
787	...	Weathered granite	Water right, 234	
788	...	Weathered hornblend schist	do. 189	
789	...	Decomposed schist	Lady Sherry, G.M.L. 2835z	
790	...	Gneissic granite	Lady Mary, G.M.L. 3121z	
791	...	Bedded kaolin	Water right, 262	
792	...	Siderite, on gneissic granite	Lady Mary, G.M.L. 3121z	
793	...	Hornblend rock (gneissic)	do. do.	
794	...	Hornblend rock	Hill upon east side of town	
795	...	Schistose diorite	do. do.	
796	...	Ironstone	Mt. Owen	
802	...	Ferruginous quartzite	Liberator East, G.M.L. 4084z	
803	...	Gneiss	Shenton Extended, G.M.L. 3124z	
804	...	Diorite schist	Liberator, G.M.L. 3821z	
805	...	Gneissic diorite	St. Albans, G.M.L. 3104z	
806	...	Gneiss	Te Pakeha, G.M.L. 4420z	
807	...	Amphibolite	Liberator, G.M.L. 3821z	
808	...	Gneiss	Jackeroo, G.M.L. 3075z	

809	...	Schist	Hardup South, G.M.L. 4234z
810	...	Diorite	Delta, G.M.L. 4336z
811	...	Mica schist	Union Jack, G.M.L. 3002z
812	...	Hornblend schist	Zeta, G.M.L. 4225z
813	...	Mica schist	Daisy Bell, G.M.L. 4061z
814	...	Weathered schist	Robbie, G.M.L. 4047z
1036	...	Sample of lode at surface	Lady Shenton, G.M.L. 2820z
1037	...	Do. do.	do. do.
1038	...	Lode stuff, showing paint gold, 60ft. level ...	do. do.
1039	..	Diorite, carrying galena and gold, 230ft. level	do. do.
1040	...	Sulphide stone, 210ft. level	do. do.
1041	...	Mineralised stone, assaying 14·70ozs., 250ft. level	do. do.
1042	...	Casing of reef	do. do.
1043	...	Wall of reef	do. do.
1044	...	Auriferous diorite (crushing stone)	do. do.
1045	...	Auriferous quartz, 160ft. level	Florence, G.M.L. 2821z
1046	369	Schistose felstone	Jowett's Well
1047	...	Serpentine schist	Princess May, G.M.L. 3113z
1048	...	Gneissic felstone	Darwin, G.M.L. 3024z
1049	...	Do.	do. do.
1050	...	Do.	do. do.
1051	...	Gneissic felstone (auriferous)	Darwin, G.M.L. 3024z
1052	...	Quartz vein in serpentine	Princess May, G.M.L. 3118z
1053	...	Fibrous serpentine	Hidden Treasure, G.M.L. 4750z
1054	...	Semi-fibrous serpentine	do. do.
1169	380	Sericite schist	Hill N.W. of Emu, G.M.L. 5164z
1170	...	Do.	Hill south of Springfield, G.M.L. 4950z
1171	...	Weathered schist	Hill N.W. of Emu, G.M.L. 5164z
1172	...	Gneiss	Half-mile east of Emu, G.M.L. 5164z
1173	1	Felsite dyke	South of the Water Reserve fence
1174	379	Banded quartzite	Hill half-mile N.E. of Merry's Well
1175	...	Silicified diorite	do. do.
1176	...	Weathered sericite schist	do. do.
1177	...	Iron ore (limonite)	Road half-way between Woolgar and Merry's Well

Registered Number of Specimen.	Registered Number of Micro-slide.	Name of Specimen.	Locality of Specimen.	Remarks.
1178	...	Pisolitic iron ore with secondary silica ...	Half-mile west of Merry's Well	
1179	380	Quartz schist	Hill N.W. of the Emu, G.M.L. 5164z	
1180	26	Hornblend schist	Hill north of Merry's Well	
1182	...	Quartz	Half-mile east of Emu, G.M.L. 5164z	
1184	...	Sericite schist	Hill N.W. of Emu, G.M.L. 5164z	
1185	...	Weathered felsite	Barunga Brave, G.M.L. 4691z	
1186	...	Granitic gneiss	Explosive Reserve	
1187	...	Weathered schist	Half-mile east of the Emu, G.M.L. 5164z	
1188	...	Sericite schist	Quarter-mile S.W. of Emu, G.M.L. 5164z	
1189	...	Quartzite	Barunga Brave, G.M L. 4691z	
1190	...	Sericite schist	Ulster, G.M.L. 4757z	
1191	...	Quartz porphyry	South of the Water Reserve	
1192	...	Hornblend diorite	S.E. corner of Water Reserve fence	
1193	...	Weathered schist	Ridge half-mile N.E. of Merry's Well	
1194	...	Felsite dyke	Ridge three-quarters-mile N.W. of Merry's Well	
1195	...	Mica schist	Ridge half-mile N.E. of Merry's Well	
1196	...	Serpentine schist	Hill east of Emu, G.M.L. 5164z	
1197	...	Pyriteous lode stuff	Czar, G.M.L. 4678z	
1198	...	Amphibolite	do.	
1199	...	Mica felsite	N.W. of Merry's Well	
1200	...	Decomposed granite	Road between Woolgar and Merry's Well	
1201	...	Serpentine schist	Half-mile east of Emu, G.M.L. 5164z	
1202	...	Quartzite	Hill half-mile N.E. of Merry's Well	
1203	...	Ironstone	Half-mile east of Emu, G.M.L. 5164z	
1204	...	Do.	Half-mile S.W. of Emu, G.M.L. 5164z	
1205	...	Diorite	Half-mile N.E. of Woolgar	
1206	...	Do.	Ridge half-mile N.E. of Merry's Well	
1207	...	Pyrites lode stuff	Czar, G.M.L. 4678z	
1208	...	Do.	do.	
1209	...	Quartz in decomposed rock	Menzies Mt. Morgans, G.M L. 4552z	

1210	...	Mica schist	do. do.
1211	...	Do.	Half-mile south of S.W. corner of Water Reserve
1317	...	Mica felsite	Water Right 226
1318	...	Hornblende schist	do.
1319	...	Muscovite granite	Durable, G.M.L. 3112z
6311	...	Quartz and Pyrites (mineral lode)	Queensland Menzies, G.M.L. 3836z
6312	...	Auriferous diorite	do. do.
6313	...	Glaucophane	Flat north of Merry's Well
6314	...	Auriferous quartz and pyrrhotite	Menzies Consolidated, G.M.L. 4935z
6315	...	Limestone	Near Emu, G.M.L. 5164z
6316	...	Do.	Corner of G.M.Ls. 4781z and 4359z
6317	...	Limonite	S.E. corner of Water Reserve
6318	...	Granite	G.M.L. 3112z
6319	...	Orthoclase	do.
6320	...	Quartzite	Springfield Road, S.E. of G.M.L. 4359z
6321	...	Sericite schist	do. do.
6322	...	Dolomite	Crusoe, G.M.L. 2823z
6323	...	Asbestos	do. do.
6324	...	Schist from fault wall	Queensland Menzies, G.M.L. 3836z
6325	...	Serpentine schist	Crusoe, G.M.L. 2823z
6326	...	Hornblend schist (weathered)	do. do.
6327	...	Do. do. (micaceous)	Shaft half-mile west of Goodenough, G.M.L. 4855z
6328	...	Mica schist	do.
6329	...	Amphibolite	Shaft north of Goodenough, G.M.L. 4855z
6330	..	Do.	Menzies Alpha Leases, G.M.L. 3031z
6331	...	Aphanitic diorite	Menzies Gold Estate, G.M.L. 3054z
6332	...	Mica schist	Golden Age, G.M.L. 2830z
6333	...	Do.	do. do.
6334	...	Crushed porphyritic granite	do. do.
6335	...	Quartz porphyry	McClay's Welcome, G.M.L. 3744z
6336	...	Porphyritic granite	Lady Shenton, G.M.L. 5006z
6337	...	Weathered porphyritic dyke	Goodenough, G.M.L. 4855z
6338	...	Do. do. do.	Golden Shoe, G.M.L. 4861z
6339	...	Granite	Water Right 193

APPENDIX II.—*List of Specimens in the Geological Survey Museum from the Menzies District*—continued.

Registered Number of Specimen.	Registered Number of Micro-slide.	Name of Specimen.	Locality of Specimen.	Remarks.
6340	...	Sericite schist	Goodenough, G.M.L. 4855z	
6341	...	Weathered porphyritic dyke	Ray's Water Shaft	
6342	...	Mica schist	Florence, G.M.L. 2821z	
6343	...	Weathered porphyry	Princess, G.M.L. 2829z	
6344	...	Gneissic rock	N.W. corner of G.M.L. 4861z	
6364	...	Mica schist	Goodenough, G.M.L. 4855z	
6365	...	Sericite schist	G M.L. 4789z and ridge to southward	
6366	...	Crushed granite	Federal, G.M.L. 4885z	
6367	...	Felsite	Quarries in Water Reserve	
6368	619	Do.	do. do.	
6369	620	Do.	do. do.	
6370	...	Do.	do. do.	
6371	...	Porphyritic dyke	Warrior, G.M.L. 3048z	

NOTE.—Specimens numbered from 750 to 1319 were collected by Mr. Campbell when acting as Topographical Surveyor.

INDEX TO NAMES OF PLACES, MINES, REEFS, Etc.

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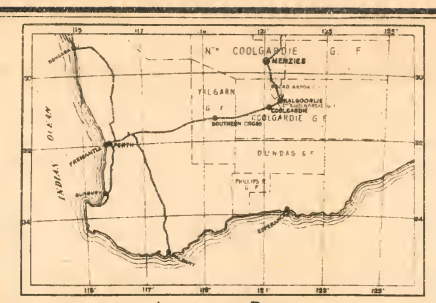


LOCALITY PLAN

8509

Commonage

5168

Racecourse

3848

Cemetery

Rifle Range

MEN ZIES

TOWNSHIP

5739

Water Res.

5064

Water Res.

Rifle Range

5188

Explosives

4582

Recreation Re

Mt MISERY

WOOLGAR (YUNDERIN) TOWNSHIP

A

B

C

D

The Hon. H. Gregory M.L.A.
Minister for Mines

GEOLOGICAL MAP OF MENZIES

NORTH, COOLGARDIE, G. F.

BY

Harry P. Woodward

ASSISTANT GOVERNMENT GEOLOGIST

Topography by W. D. Campbell.

1905

0 40 80 120

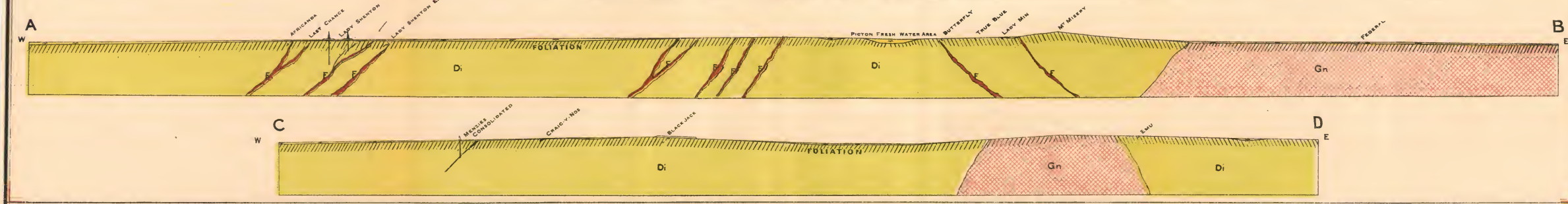
Scale of Chains

EXPLANATION OF COLOURS & SIGNS.

RECENT	ALLUVIUM	Clay, loam, sand & gravel of flats & creek beds	
	LATERITE	Brown Hematite (Ironstone) Ferruginous clay stone & Conglomerates (Cainozoic) capping the hills & ridges	X
CRYSTALLINE AND ALTERED ROCKS	BASIC	Serpentine & Chloritic schists, Amphibolite Aphanitic Diorite & other Hornblende & Allied Rocks	D
	ACID	Sericite, Mica Schists, Quartzite & Granite	Gn
IGNEOUS ROCKS, DYKES		Felsitpathic, Porphyritic & Granitic	F
DRY BLOWN PATCHES			
QUARTZ REEFS		GEOLOGICAL BOUNDARIES	
DIRECTION OR DIP OF LODES OR REEFS		FOLIATION	
LEASES: NAME OF HOLDERS OF BOUNDARIES OF		LADY SHENTON 2820°	ESTATE LEASES (Which have prefixed Case) 3158
SHAFTS		CONTOUR LINES 10 ft INTERVALS, DATUM SEA LEVEL	
WATER RIGHT	W.R.	MINERS HOMESTEAD LEASE M.H.L.	TAILINGS AREA T.A.

R. H. Brown del 6/12/05

SECTIONS ON LINES A TO B & C TO D



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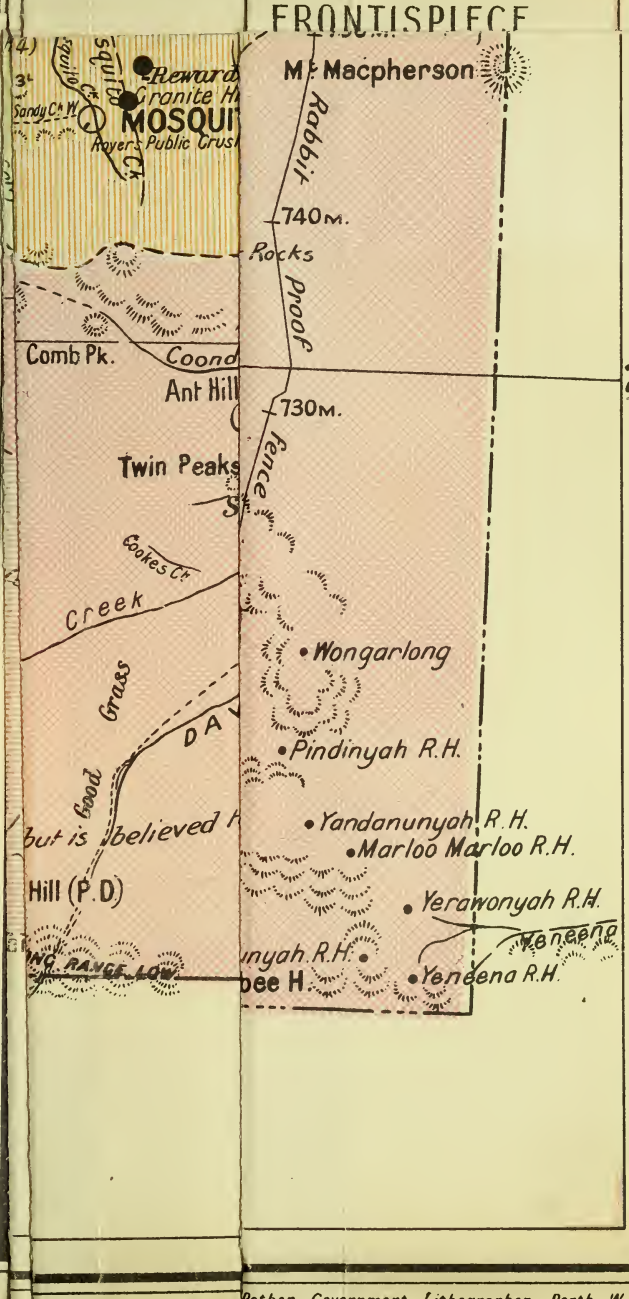

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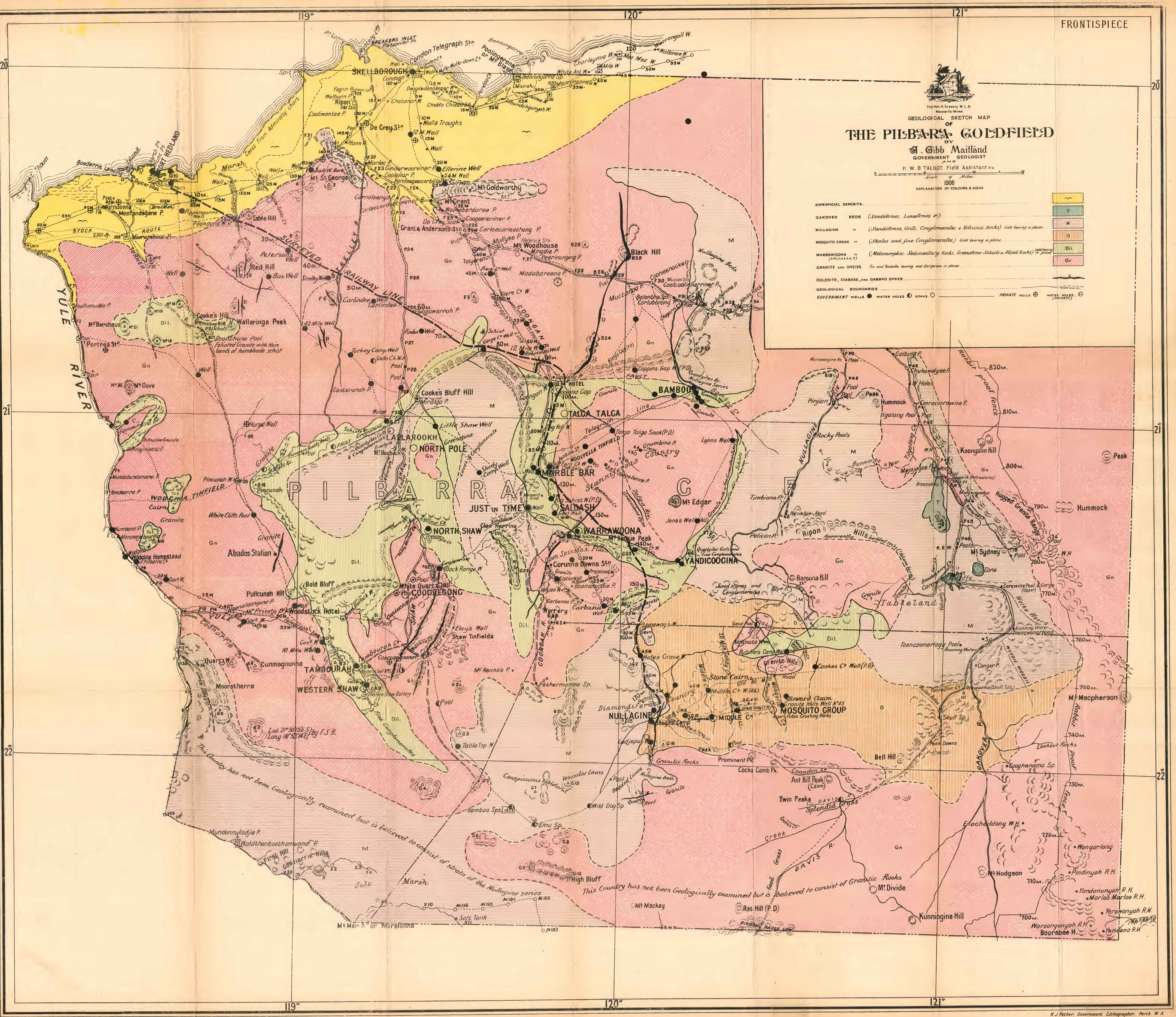

H. J. Pether, Government Lithographer. Perth. W. A.

1906.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 23.

THIRD REPORT ON THE GEOLOGICAL FEATURES AND MINERAL RESOURCES OF THE PILBARA GOLDFIELD,

BY

A. GIBB MAITLAND,

Government Geologist.

Issued under the authority of the Hon. H. Gregory, M.L.A., Minister for Mines.

WITH 7 GEOLOGICAL MAPS AND 13 FIGURES.

PERTH:

BY AUTHORITY: FRED. WM. SIMPSON, GOVERNMENT PRINTER.

1906.

PREFATORY NOTE.

THIS report completes the descriptions of those mining centres in the Pilbara Goldfield to which no reference was possible in Bulletins 15 and 20. The report includes full details with reference to the gold-mining centres of Tambourah, Western Shaw, North Shaw, and Just-in-time, together with that of the tinfields of Wodgina and Cooglegong, and is accompanied by geological and mining maps, without which the descriptive portions would be practically unintelligible.

In order to render the information as complete as possible, the report of the late Mr. S. J. Becher, at one time Inspector of Mines for the district, upon the North Shaw centre, has been laid under contribution.

This third report contains, in addition, a general summary of the geological features, mineral resources, and future prospects of the whole goldfield; the direct results of a personal investigation of all the centres (except North Shaw) at which mining was being or had been carried on.

In the fieldwork I was associated throughout, as in the two previous seasons, with Mr. H. W. B. Talbot, Field Assistant, to whose co-operation the rapid completion of the field plans is in no small measure due.

The index to names, places, reefs, etc., occurring in the report has been prepared by Mr. P. J. Atkins, Clerk to the Geological Survey.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Perth, 9th May, 1906.

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APPENDIX I.

THIRD REPORT

ON

The Geological Features and Mineral Resources

OF

THE PILBARA GOLDFIELD.

PART I.—Descriptive Geology.

The general reconnaissance of the Pilbara Goldfield, commenced in 1903, was completed at the close of the field season of 1905. On this occasion the portions of the district not previously visited were reached by way of Roebourne, and the Pilbara Goldfield entered by the crossing of the Yule River at Womerina Pool.

Close by Womerina Pool is the site of a small alluvial gold rush some little time ago. The pool itself lies at the foot of a long serrated ridge, which forms a gigantic horseshoe of several miles in length, the southern arm of which returns to the Yule River near Minnaginienna Pool, some miles to the south of Womerina.

At the latter place the banded quartz which constitute the horseshoe range is of considerable thickness and underlies at a very high angle to the south. At the scene of the alluvial rush near Womerina, the laminated quartz has been subjected to a considerable amount of disruption (Fig. 1). A well marked fault trending generally 156 degrees is seen traversing the banded quartz which forms high cliffs in the vicinity.

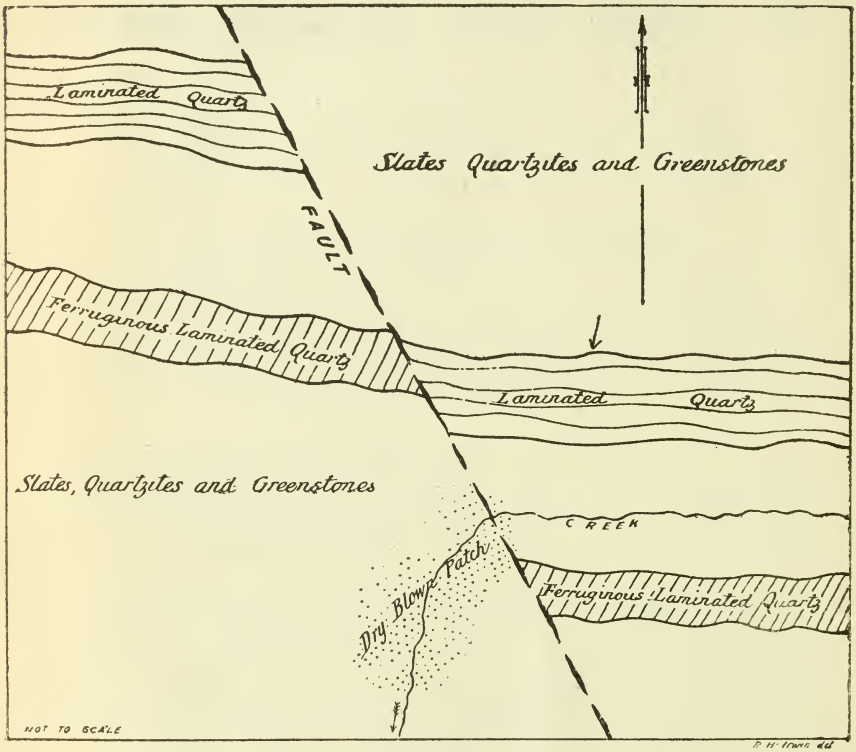
A small creek, falling into the Yule River and draining the valley between two readily identifiable beds, has been the one which seems to have carried the bulk of the gold. Judging by the condition and situation of the workings, the gold seems to have been concentrated in the vicinity of the fault which crosses the valley almost at right angles. The laminated quartz veins are associated with quartzites, slates and cleaved greenstones of the type common to other Pilbara centres.

Up the valley between the arms of the horseshoe, the country rock is granite which forms part of that occupying such extensive areas in the district. Where the range is crossed by the track to the

Wodgina Tinfield, the slates and other associated rocks give place to granite, which sends out veins and dykes into them.

Considering the identity of the geological structure of this range with other portions of the district in which tin mining has been carried out, there seem good grounds for advising that attention should be paid to prospecting the margin of the intrusive granite in this neighbourhood in the hope of finding tin also.

Fig. 1.



SKETCH PLAN AT WOMERINA POOL. YULE RIVER.

From the Womerina Range to Wodgina the track passes over nothing but granite of the prevailing type; this, however, gives place in the vicinity of the latter locality to a series of highly inclined metamorphosed sedimentary and igneous rocks. These have been very much folded and faulted, and they occupy a rugged range which rises to considerable altitudes above the general level of the surrounding granite plains. The metamorphic beds are pierced by granite and pegmatite veins, which emanate from the main mass; these rocks are fully described on a later page (p. 47) under the heading of the Wodgina Tinfield.

In certain parts of the Wodgina field, at the Stannum group of leases, the rocks are traversed by an older series of acidic dykes, which have been very much cleaved and sheared, and are intersected by the newer pegmatitic granite veins of the Wodgina type.

The intrusive granite of Wodgina occupies the whole of the watershed of the Yule River to a point at the foot of the Mungaroona Range, below Cangan Pool, on the western branch of the river, and extends without interruption as far to the eastward as Tambourah and Western Shaw. In the vicinity of Tambourah and Western Shaw, the older crystalline schists, which form the matrices of the auriferous quartz reefs of these centres, again make their appearance and occupy a fairly extensive belt. Everywhere along the margin the granite is found sending out tongues and veins into the schists, and in many cases large lenticular masses of schist have been caught up in the granite. Full details regarding the geology of this part of the field are given on a later page (p. 13) in that portion of the report which includes the descriptions of individual centres.

Leaving Western Shaw *en route* for the Cooglegong Tinfield, we followed the belt of schists as far to the southward as the junction of the Tambourah and Western Shaw creeks. A little to the east of this the schists give place to granitic gneiss, which may represent the portions of the older schists which have been absorbed by the intrusive granite.

The granite of Cooglegong occupies a wide expanse of country, and extends over an area of some hundreds of squre miles.

From Cooglegong our route lay by way of the Black Range Well, on one of the tributaries of the Shaw. In the vicinity of this the granite is covered by the basal conglomerate of the Nullagine Series, which, with its associated volcanic rocks, occupies the country as far as Just-in-Time, where an auriferous ferruginous conglomerate at the base of the series has been mined. Full details regrading the geology of this centre are given on a later page (p. 39), in that portion of the report which describes the different mining centres.

From Just-in-Time to Marble Bar the route traverses the crystalline schists of the Marble Bar-Yandicoogina belt, which have been fully described in previous reports; hence no further reference need be made thereto in this place.

Mr. H. W. B. Talbot, the Field Assistant, on returning to Roebourne with the horses and equipment, furnished the following report on a traverse from Marble Bar to the Turner River:—

"The route followed was *viâ* Cooglegong, and, as you had already been over that road, no notes were made regarding the geological structure of the country traversed. From the Shaw River I travelled *viâ* Dead Bullock Well and Abados Station to Green's Track.

"Leaving the Shaw River, the track skirts along the southern edge of a bold range for about four miles, the country being underlain by granite. The granite then gives place to schists, which have a general strike of nearly north and south. Judging by the veins of granite outcropping at the edges of the schist, the granite would appear to be intrusive into the latter. The road traverses the schist for about three miles, when the country rock again consists of granite, which in many places rises into hills covered with little or no vegetation. When the track leaves the granite it crosses the northern continuation of the Tambourah and Western Shaw belt, which at this point is about four miles wide, and consists of slates, quartzites, and fine conglomerates, traversed longitudinally by numerous laminated ferruginous quartz reefs. The general strike of the rocks is in a northerly and southerly direction. After traversing this belt the road emerges into the large granite plain, which occupies such a large area in this portion of the Pilbara Goldfield.

"Near Abados Station several greenstone dykes outcrop and strike about north-north-east. One of these dykes rises abruptly from the plain and, extending for several miles across country, forms a conspicuous feature in the landscape.

"At White Cliffs Pool, on the Turner River, and about nine miles from Abados, an area of about one square mile is occupied by a dark-coloured igneous rock, much weathered, and possessing a schistose structure. Its relation to the granite was not ascertained. At the pool this rock is overlain by a pure white travertine, which, on the west bank of the river, forms cliffs about 40 feet in height.

"From White Cliffs Pool to Green's Track the road runs close to the Turner River, and the rock seen on the roadside consists solely of granite.

"A description of the country from the intersection of the Turner River by Green's Track has already been published,* and therefore does not need repetition."

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*Annual Progress Report of the Geological Survey for the Year 1904. Perth: By Authority, 1905. pp. 147-149.

PART II.—Descriptions of Individual Mining Centres.

A.—TAMBOURAH.

(*With a Geological Sketch Map. Plate I.*)

The mining centre of Tambourah is situated about 75 miles south-west of Marble Bar, upon the head-waters of the creek, from which it takes its name, and which forms one of the important branches of the Shaw River. The old mail coach road from Roebourne to Nullagine passes through both Tambourah and Western Shaw.

The mining centre lies just to the west of the junction of the greenstone with the intrusive granite, which extends without any interruption as far as the old Pilbara mining camp (also on the fringe of the granite), about 70 miles to the north-west. The auriferous belt, so far as has yet been proved, extends for about a couple of miles due north and south, at an average distance of about a quarter of a mile east of the granite junction, as may be seen by an inspection of the geological sketch map.

Nineteen gold mining leases were in force at Tambourah during one period of its history, but at the present time there are none, and the locality now presents a very prosaic appearance.

A Government well, 97 feet in depth, had been sunk on the south bank of Tambourah Creek, at the spot indicated on the map. From the bottom of the well a drive had been put in 12 feet north-west. The water, which is estimated at about 100 gallons per hour, proved to be fresh.

The country in the vicinity of Tambourah consists of a series of low undulating hills, which rise to no conspicuous altitudes above the general level of their surroundings.

Firewood and mining timber are not abundant, but doubtless sufficient to supply the wants of a small centre for a few years might be obtained within reasonable distance of Tambourah.

History.

Very little appears to have been officially recorded of the early history of Tambourah. The Acting Inspector of Mines for the Northern Goldfields, in his report for the year 1894-5, writes of Tambourah Creek :—

> Lying also on the outskirts of another vast granite area, which stretches away north-westwards. The character of the country differs from that of Western Shaw somewhat, the hills being low and more rounded. The formations, too, consist mainly of hornblende schists, diorite, and opaline. The outcrops of the reefs are small, but they mostly widen out in depth. Very rich stone has been obtained from some of the workings, and

the general character of the quartz is very "kindly." Some is highly mineralised with ores of iron, copper, and manganese. From Tambourah Creek north-westwards for some 80 miles along the eastern side of the Yule River there extends a vast area of granite country, apparently reaching back eastwards to the Upper Shaw Country.*

The following year the same officer reports:—

With the probability of erection of batteries at the North Shaw, and also at Tambourah Creek, these two very promising centres should soon advance considerably in importance.†

The Warden, in his report on the Pilbara Goldfield for the year 1897, informs the Minister for Mines that:—

Tambourah Creek, situated 75 miles south-west of Marble Bar, has a population of about 40. It enjoys the convenience of a post and telegraph office, a wayside house, and two stores. One battery is erected, and a Peruvian mill is being erected. The only Company interested in this district is the World's Fair Mining Co., Ltd., who hold four leases. There are, besides, nine other leases and three protection areas. The yield of gold for the year was 305ozs. out of 142 tons.‡

In his report for the year 1901, the Warden writes that:—

Mining matters at . . . . . Tambourah, Western Shaw, ... were very dull, only a few miners being employed.§

No further mention is made of the progress of Tambourah in the Annual Reports of the Department of Mines since 1901; the field having gradually declined until at the present date it may be said to have been practically temporarily abandoned.

Owing to difficulties connected with obtaining their stone crushed, the owners of the Kirkpatrick Mine, G.M.L. 464, erected in 1898 an arrastra on the granite rise, on the southern bank of Tambourah Creek at the spot shown on the map. It appears, however, that the arrastra did not prove an unqualified success, for though it did excellent work in reducing the ore to a fine powder, it was two slow for the owners.

General Geology.

In its geological structure the neighbourhood of Tambourah is comparatively simple, there being practically only two formations within the limits of the area mapped, viz., granite and its derivatives; and greenstone and its transmuted varieties.

The Granite.

The granite occupies the western portion of the field, and forms the margin of that large mass which extends for considerable distances to the north, south, and west. The granite is intrusive, and sends out veins into the greenstones, in addition to containing extensive masses of the latter, more especially along its margin.

* Report of the Department of Mines for the year 1895. Perth: By Authority, 1896, p. 30.
† Report of the Department of Mines for the year 1896. Perth: By Authority, 1897, p. 36.
‡ Report of the Department of Mines for the year 1897. Perth: By Authority, 1898, pp. 23-24.
§ Report of the Department of Mines for the Year 1901. Perth: By Authority, 1902, p. 45.

One very conspicuous mass of intrusive granite, about eight chains in maximum width, makes its appearance in the Tambourah Queen Lease, and extends due north for a distance of about 30 chains. This mass is traversed by several quartz reefs, one of which intersects both granite and the enclosing greenstone.

In its characters the granite presents much uniformity, a typical example of it [6487] being exposed in the operations connected with the erection of the arrastra on the southern bank of Tambourah Creek. The granite, as developed in this locality, is of a light grey colour, of medium grain, and consists, so far as may be judged by an examination with the unaided eye, of quartz, felspar, and small quantities of a white or pale-green mica. Microscopic examination does not disclose anything of especial note in regard to its structure.

One of the granite dykes which traverses the Western Chief Lease is composed of a rock of much finer grain [6488] than the rest of the granite. The rock has undergone a certain amount of crushing, and in hand specimens presents all the characters of a fine-grained granitic schist (granulite?). Both black and white micas can be recognised by the unaided eye. Examined microscopically the rock is found to consist principally of a fine-grained mosaic of quartz and felspar, through which are scattered numerous larger aggregates of quartz grains. The micas are now represented in the slide by ferrite, though a little sericitic mica can be detected.

Further to the eastward, and in the same dyke [6490], at a greater distance from the granite, the rock is of a much finer grain, and exhibits a much more platy and semi-schistose structure. Under the microscope its presents no essential differences to that previously described, beyond that in the fine quartz-felspar mosaic a marked lineation, which is not at first very conspicuous, can be detected.

The Greenstones and their Derivatives.

The eastern portion of the district is occupied by basic rocks, which, so far as observations have at present been carried, belong to one type, and such differences as they present being brought about by causes operating after their consolidation. All these rocks are affected by foliation, the lines of which have a general trend of north and south, with a very high inclination to the eastward. In some cases the rocks are hornblende-schists, and at others massive greenstones; they are all dark, heavy rocks [6485, 6486, 6489, 6493], and an important characteristic of most of them is the abundance of both brown and green hornblende.

A specimen of the schistose variety [6485] from a mass which has been involved in the granite, near the western margin of the map, when examined under the microscope, is found to consist principally of hornblende, some of which shows the characteristic prismatic cleavage. The matrix in which the hornblende lies consists chiefly of grains of fresh coloured felspar, showing under crossed nicols lamellar twinning; the felspar contains acicular

inclusions of apatite (?). There is a relatively small quantity of iron ore which is in all probability ilmenite.

What appears as a long dyke of greenstone [6486] outcrops on the eastern boundary of the Duke of Wellington and the Corunna Leases; it may, however, be merely an attenuated patch of unmodified greenstone, which has escaped total destruction. Under the microscope, the rock [6486] is found to consist chiefly of hornblende, which has in most cases lost all traces of its original form, and is crowded with inclusions; the felspar is represented by cloudy patches which occasionally contain acicular needles of hornblende and apatite (?). From its mode of occurence, it seems to indicate that the felspar has undergone a more or less complete molecular reconstruction. The small quantity of iron ore appears to be ilmenite.

The country rock [6493] of the Tambourah King Reef is of a somewhat fine grain and exhibits a rude foliation in hand specimens, and contains a little iron pyrites. Under the microscope, the rock is found to be made up of brown and green hornblende, clear pellucid felspar, and fairly large quantity of iron ore, which seems to be largely ilmenite.

The rock [6489] which occurs in the Government Well is much more foliated than any of the others in the district. In hand specimens the rock exhibits more recognisable crystals, but has the appearance of a somewhat unctuous chlorite schist, and under the microscope no distinguishing features.

No observations were made regarding the effects of the contact metamorphism on the greenstones in the vicinity of the granite junction.

The Quartz Reefs.

The quartz reefs are very numerous and occur both in the granite and the greenstones, though they are more numerous in the latter.

The quartz of most of the reefs, as far as can at present be seen, is of white or amber colour; as seen underground by Mr. Inspector Becher, the stone "is heavily mineralised with iron pyrites, arsenical iron pyrites and galena being also present. Above water-level these ores have been mostly converted into oxides, leaving the stone sometimes in a honeycombed state with free gold in the spaces, pointing to the fact that the sulphides have carried gold in combination."

The reefs naturally vary in size within very wide limits; but, from what can be learnt at the present time, it appears that the smaller reefs carry the richer stone, and on the whole it may be said that Tambourah is a field of small reefs.

An inspection of the map, upon which the position of all the quartz reefs has been laid down with such a degree of accuracy as the scale and the circumstances seemed to warrant, shows that when

viewed on the whole they exhibit a rude parallelism coincident with that of the foliation of the district, viz., north and south.

The one which has the greatest linear persistence is that which traverses the Western Chief Leases, and can be followed southward without any break for a distance of about 6,000 feet, and may possibly extend further than the limits embraced by the map.

The reefs are all vertical, or at any rate are inclined at a high angle to the east. The longest reef, viz., the one previously described, passes in its northern portion into a very banded form, identical in every respect with those laminated quartz veins which form such conspicuous features in the geology of other centres in the Pilbara Goldfield and the other mining fields throughout the State.

The quartz reefs of Tambourah have yielded up to the close of 1905 3,606·21ozs. of gold, derived from the milling of 2,253·25 tons of quartz, or at the rate of 1·60ozs. per ton.

It has been shown that the relation between the granite and the greenstone is that the former is intrusive into the latter, and that the quartz veins traverse both series indiscriminately, although they are much more numerous in the greenstone. It necessarily follows from this, and the fact has a very important bearing upon the future of this and other north-west fields, which are geologically identical, viz., that the quartz reefs are likely to be as persistent in depth as deposits of the kind can ever be, and they are not liable to be cut off by the granite as might have been the case had the formation of the reefs preceded the intrusion thereof.

The Ore Deposits and Mines.

For convenience of description, the ore deposits and workings are described in geographical sequence, commencing at the northern end of the field.

Brilliant, G.M.L. 410 (formerly G.M.L. 265).—This is an isolated lease lying about a little over half a mile due north of the Corunna, and is in all probability traversed by the extension of that long line of reef which crosses the Duke of Wellington and the Corunna Leases, and has been followed about a quarter of a mile due north up to the boundary of the Geological Map. No work was going on at the date of my visit, hence no inspection of the lease was made. Only a few ounces of gold have been obtained from this property, the details in connection with which are given in the table below.

Table showing the Yield of the Brilliant, G.M.L. 464.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	35·00	21·60	·61

Kirkpatrick, G.M.L. 464.—This is an old unsurveyed lease, situated about 10 chains north 70 degrees east from the Brilliant Lease, and lies just outside the northern boundary of the Geological Sketch Map (Plate I.). No work was going on at the date of my visit, and had not been for years, hence the property was unvisited.

The following table gives the official returns from the property, as deduced from official data :—

Table showing the Yield of the Kirkpatrick, G.M.L. 464.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	88·00	208·50	2·36

Corunna, G.M.L. 272.—This 12-acre lease, which adjoins the Duke of Wellington on the north, is traversed by three distinct lines of reef. The westernmost reef which is coterminous with that in the adjoining lease, outcrops at an average distance of about 80 feet from the western boundary, and can be readily followed along the surface for about 800 feet northwards. This reef has been opened out by an underlay shaft, stated to have been carried down to a depth of about 30 feet, but is inaccessible at the present time. The reef appears to be small, and the prospects are stated not to have been very encouraging. There seems to be good grounds for the belief that this reef may be the northern extension of that outcropping in the Tambourah King Lease (*q.v.*).

Two hundred and fifty feet east from the previously mentioned shaft is another, sunk to a depth, of which there is no record, upon one of the most persistent lines of reef occurring within the limits of the country examined. This reef, which traverses the whole length of the lease, at an average distance of about 100 feet from the eastern boundary of the property, can be followed continuously along the surface for a distance of about 3,000 feet, and for a considerable distance beyond the limits of the Geological Map (Plate I.). The reef, which is small, is encased in the planes of foliation of a very hard hornblende schist.

Three hundred and forty feet to the south-east of the westernmost shaft is another sunk to a depth, of which there appears to be no record, on a well-defined quartz reef, underlying east at a very high angle. The reef, which is small, can be followed along the strike for about 500 feet, and extends into the adjoining lease on the south.

Another small but well-defined reef outcrops at about 220 feet from the south-west angle of this lease, not far from the boundary of the intrusive granite. This reef has been opened out by a prospecting shaft, sunk however only a few feet; it can be readily followed along its outcrop for a distance of about 500 feet.

Duke of Wellington, G.M.L. 264.---The southern portion of this 12-acre lease is traversed by Tambourah Creek, which in this part of its course has a width which varies from 150 to a little over 200 feet.

Three distinct lines of reef traverse the property in a general north and south direction. At the time this property was at work, in the year 1896, these different reefs were respectively known by the names of the "King," the "Intermediate" and the "Chief," in the belief, for which there seem to be some sound geological reasons, that they represented the northern extension of the main lines of reef traversing the Tambourah King and the Western Chief Leases.

The westernmost reef (The King Line) is described by Mr. Becher as consisting of three small parallel leaders outcropping within a space of 20 feet, and can be traced right across the property. This reef has been opened up at intervals along its outcrop over a distance of about 200 feet. The reef is enclosed in a dark micaceous schist and underlies at a very high angle to the east. A shaft has been sunk upon it to a depth, of which there is no record; at the surface the reef was only a few inches in thickness, but at a depth of 30 feet (at which depth good drinkable water was encountered) it had increased to 24 inches. This shaft, as are all the others on the field, is inaccessible. Another shaft has been put down upon the same reef, at a point about 40 feet northwards and attained a depth of 25 feet; from this depth it is stated that a south drive was commenced with the object of connecting with the first mentioned shaft.

No other work of any importance appears to have been done upon the other lines of reef.

The Western Chief, G.M.L. 567 (l. 536).--This lease of 12 acres, embracing the original prospecting area granted to Mr. E. Barnes, was taken up in its present shape by Mr. J. S. Forbes in the year 1898 under the same name.

The reefs worked in the adjoining property (the Western Chief) on the south traverse the whole length of the lease, and judging by the condition of the surface, a considerable amount of work must have evidently been carried out. The ground having been abandoned since the year 1901, all the workings being inaccessible (as well as there being no plans of the mine lodged with the Government), no information as to the condition of affairs prevailing underground is available.

Two well defined quartz reefs traverse the whole length of the lease; and a well marked band of laminated quartzite outcrops at a distance averaging from 20 to 60 feet to the east of the main reef, and continues northwards without any break as far as the southern bank of the Tambourah Creek. This band, which forms an important feature in the structural geology of the field, can be followed southwards through the Western Chief and the Alexandra, where it merges into a quartz reef; it thus has a continuous outcrop

of over 6,000 feet within the area embraced by the map which forms Plate I.

The westernmost reef, which is continuous from the Western Chief Lease, enters the property at a point on the southern boundary, about 140 feet east from the peg at the south-west angle of the lease, and can be followed without any break northwards, where it passes into vacant ground at a point on the northern boundary about 340 feet east of the north-west corner. It, however, has only been opened up at one spot 140 feet distant from the northern boundary of the lease; here a pothole but a few feet deep exposes a little over 12 inches of a somewhat ferruginous quartz. The main reef, which is parallel to this one, and about 100 feet to the east of it, is likewise continuous throughout the whole length of the property. The reef has been opened up by seven or eight shafts, the positions of which are shown on the map. These shafts having all fallen in, are not now accessible.

What is known as the P. A. is now embraced within the limits of the Western Chief Lease, and, according to the issues of the *Northern Public Opinion*, during 1898 174 tons of ore yielded 213·60 ounces of gold. The details are given for what they are worth in the table below; in all probability, however, these amounts have been included in the yield of the Western Chief Lease for 1898.

Return showing the Yield of the P. A.

Year.	Ore treated.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	*103·00	†103·00	1·00
1898	* 48·00	72·00	1·50
1898	‡ 23·00	38·60	1·67
Total for 1898 ...	**174·00**	**213·60**	**1·22**

* *Vide Northern Public Opinion* for 25th June, 1898. † The paper states that the 103 tons yielded "a little more than an ounce per ton." ‡ *Vide Northern Public Opinion* for 20th August, 1898.

The following table gives the yield of the Western Chief reef in so far as such can be obtained from official sources:—

Table showing the Yield of the Western Chief, G.M.L. 567 (l. 536).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	183·00	225·00	1·23
1899	363·00	416·75	1·14
1900	108·00	122·15	1·13
Total	**654·00**	**763·90**	**1·16**

Western Chief No. 1 South, G.M.L. 568 (l. 258).—This twelve acre lease, which occupies the central position of the Tambourah properties, was originally taken up in the year 1895 by Messrs. Murcott and others, under the name of the Western Chief, and numbered G.M.L. 258. On being abandoned it was re-taken up by Mr. J. S. Forbes, under the same boundaries, and registered under the number and name by which it is at present known. It is much to be regretted that the name of the lease has been altered, as great confusion is apt to arise on the part of the general public, more especially in cases in which personal acquaintance with the district is wanting.

Near the western boundary of the lease and on the high ground the outcrop of a remarkably well defined quartz reef can be traced right across the whole length or breadth of the property. This reef has been opened out at one spot only, distant about 140 feet from the northern boundary of the ground. Here at a spot where the reef traverses a dyke of what is now granitic schist, a vertical shaft has been sunk to a depth of 10 feet. The northern face of the shaft exposes 2 feet 6 inches of quartz inclined at an angle of 75 degrees to the east. The footwall of the reef is a micaceous granitic schist (?), whilst the hanging wall is a dark micaceous schist. The mica schist contains stringers of quartz, whilst the reef itself occurs along the bedding (or foliation) planes. As seen underground in this shaft the impression left on the mind is that the reef is merely another phase of the silification of the country rock, along a well defined line of weakness. The quartz is white and certainly does not present a promising appearance. Mr. Inspector Becher's notes indicate clearly that the quartz of this reef is "poor."

Prospecting operations have apparently been centred upon the reef lying about 60 feet to the eastward. This reef seems to have been exploited by four shafts, the positions of which are shown upon the map which forms Plate I.

Mr. Becher gives several particulars with regard to the workings on this lease; it is unfortunately not quite clear which of the shafts shown upon the map are those to which his descriptions refer. As these observations (1896), which are those of an eye-witness, may have some value, his words are quoted *in extenso*:—

"Upon a well defined reef near the main reef (*i.e.*, the westernmost reef) an underlay shaft has been sunk to water level, 75 feet. At the 60-feet level a drive is being commenced north; here the reef shows about 18 inches of quartz; the average width of all stone showing being about 10 inches. About 25 tons of stone lie at grass, a rough sample from which gave a 2oz. prospect. The reef strikes north 20 degrees east and underlays east at an angle of 70 degrees. On the same line of reef 80 feet to the northward another shaft has been sunk 25 feet. Down to water level the ground on this line is a soft decomposed hornblende schist, and at water level becomes

harder. On a line farther east a vertical shaft has been sunk 54 feet to cut the reef in depth, but failed to do so, and a crosscut of 10 feet had to be made. A crosscut of 40 feet has also been made west to cut a rich leader prospecting well on the surface. On this same line farther south, an underlay shaft has been put down 35 feet, the stone averaging eight inches. Rough sample along this line gave a 3oz. prospect (said to be exceptionally good). Twenty tons at grass."

Another well defined reef outcrops about 220 feet east of that last described, and three shafts have been put down upon it at positions indicated on the map. It is possible that the latter portions of Mr. Becher's descriptions refer to this line; the shafts, however, are at the present time absolutely inaccessible.

Table showing the Yield of the Western Chief No. 1 South, G.M.L. 568 (l. 258).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1890	72·00	79·17	1·09
1900	30·00	40·00	1·33
1901	...	*130·14	...
Total	**102·00**	**119·17** *130·14	**1·16**

* From tailings.

Alexander, G.M.L. 255.—This is a 9 acre lease, which adjoins the Western Chief on the south. As may be seen by an inspection of the geological map (Plate I.), the lease is traversed by the same lines of reef as outcrop in the Western Chief and the Young Australia. The principal mining operations appear to have been concentrated upon the southern extension of the most easterly of the Western Chief Reefs. A vertical shaft, stated to have been 47 feet in depth, has been sunk on this reef at a point about 180 feet from the northern boundary. This shaft is inaccessible, but the late Mr. Inspector Becher's notes state:—That the reef averaged from 6 to 8 inches in thickness; that the stone prospected well throughout; that a "rough sample gave a 5ozs. prospect." A drive had been put in to the south from the foot of the shaft, where the stone seemed to be increasing in size, but no particulars are available respecting it.

Young Australia, G.M.L. 261.—A twelve-acre lease, lying about 120 feet north of the Western Hero Group. This property is traversed by a well defined quartz reef (which the field evidence points to being the northern extension of the east reef of the Western Hero No. 1 North), outcropping at an average distance of

about 200 feet from the eastern boundary of the lease. The reef has been "open-cut" for about 480 feet along its outcrop, and an inaccessible shaft put down on it at a point about 200 feet south from that peg on the northern boundary which separates G.M.Ls. 255 and 341. A good deal of stone must evidently have been taken out from this reef, which can be followed into the adjoining lease 341 for a distance of about 400 feet. Parallel to and about 120 feet west from the Young Australia is another quartz reef of the same type, which can be followed with more or less interruption along the outcrop for a distance of about 460 feet from the northern boundary of the lease.

Western Hero, G.M.L. 253 (formerly Kushmattie, G.M.L. 455).—A six-acre lease, the most southerly of the whole group at Tambourah, and situated about 70 chains south from the Government Well. A well defined though small quartz reef extends across the whole length of the lease, outcropping at an average distance of about 160 feet from the western boundary. The reef has been opened up by four shafts, all of which, however, are at the present time inaccessible. Just outside the southern boundary of the lease a tunnel has been put in for a few feet northwards along the reef, and about a foot of stone exposed. The total length of the outcrop of the Western Hero reef, as exposed within the limits of the geological sketch map (Plate I.) is about 1,200 feet. A parallel reef to this outcrops for about 100 feet to the west, and occupies the surface for about 300 feet, adjoining the western boundary and near the north-west angle of the lease. It has been opened out by an inaccessible shaft situated about 200 feet south of the northern boundary of the lease.

The following table gives the yield so far as such can be obtained from the official records:—

Table showing the Yield of the Western Hero, G.M.L. 253 (formerly Kushmattie, G.M.L. 455).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1897*	86·00	193·00	2·24
1898	54·50	78·65	1·44
Total	**140·50**	**271·65**	**1·22**

*The *Northern Public Opinion*, in its issues of the 6th and 13th November, 1897, gives returns which indicate that during that year 134 tons of ore crushed yielded 337·15 ozs. of gold, or at the rate of 2·51 ozs. per ton.

Western Hero No. 1 North, G.M.L. 254.—A fairly well defined reef traverses the full length of the lease at an average

distance of about 120 feet from the eastern boundary. The reef is parallel to, and a few feet east of, the Western Hero Main Reef. Not much can be seen at the present time of the reef, and the shaft by which it was exploited is now inaccessible.

Tambourah King, G.M.L. 252.—This twelve-acre lease adjoins the Western Chief on the west, and lies between it and the western tributary, which flows into Tambourah Creek at the Government Well. A well defined reef, with a northerly trend traverses the whole length of the property, and has been opened up at one time or another by four now disused vertical shafts. The reef is said to have averaged from eight to 12 inches in width near the surface.

At the time this property was visited, no work was going on, and what seems to have been the main shaft was inaccessible. A Tremaine Mill, which had been moved from the White Angel Mine, near Marble Bar, is erected on the property close to the main shaft.

According to the late Mr. Inspector Becher's notes, the development on the property consisted at the date of his visit of:—

"No. 1 Shaft.—42 feet vertical.

"No. 2 Shaft.—25 feet vertical; driving south to meet level from No. 3; now in twelve feet, very little stone in the face.

"No. 3 Shaft.—25 feet vertical, with a level to connect with No. 2, now driven 25 feet; at the bottom of the shaft, good stone 14 inches in width to be seen."

At one period in the early history of the mine, 5 tons of quartz were carted to the nearest battery at Pilbara (75 miles distant) and are said to have given a return of 6ozs. 13dwts. of gold per ton; from which it may reasonably be inferred that a very rich shoot was met with.

The *Northern Public Opinion* of 12th February, 1898, gives an account of the reef in the Tambourah King as it appeared in the lower levels of the mine, and as this is the only information as to the behaviour of the reef underground it is quoted *in extenso*:—

"From the vertical shaft in the King, the reef was struck at about 40 feet, and the stone is of splendid quality, though highly mineralised, so much so that although gold shows freely in it, treating it with the appliances which will be available here can hardly prove successful. . . . . The country is hard and the reef but of small size—about six inches where struck—but getting it in this hard country goes far to prove the continuance and permanence of the reefs about here, and shows too that the gold is going down as well as the ore-body. There has not been much occasion to doubt the permanency of the Tambourah Reefs as in no less than six or seven shafts hard country has been met with, and

in each case the reefs continue, whilst in some they increase in width and carry the gold down, although so soon as the hard ground is met with the nature of the ore alters naturally, and becomes more or less mineralised, whereas before the hard ground is reached the lodes contain comparatively little mineral and are very free to treat."

The following table gives the output of the Tambourah King Lease, so far as such can be obtained from official data :—

Table showing the Yield of the Tambourah King, G.M.L. 252.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1897	56·00	112·00	2·00
1898	30·00	42·00	1·40
Total	**86·00**	**154·00**	**1·79**

Tambourah Queen, G.M.L. 262.—A six-acre lease lying in vacant ground between the Corunna and the World's Fair properties. The surface of the lease is occupied by hornblendic and micaceous schist, which are everywhere inclined at very high angles to the east, with a general north and south strike.

A very conspicuous granite dyke occupies a considerable portion of the eastern area of the lease, attaining a maximum width of about 200 feet along the northern boundary of the property. A well-defined though small quartz reef, having an outcrop of about 900 feet in length, lies at an average distance of about 100 feet from the western boundary of the lease, and has been more or less perfunctorily worked. Judging however from the present condition of the surface, it would seem that very little stone can have been raised. The reef underlies at a high angle to the east, and occurs along the bedding (foliation?) planes of the schist.

World's Fair No. 1 North, G.M.L. 259.—This twelve-acre lease adjoins the World's Fair on the north. There are one or two short reefs outcropping on the property, but no work seems to have been done upon any of them. The country rock is basic schist of the usual type.

World's Fair, G.M.L. 256.—The northern portion of this twelve-acre lease is situated on the high ground to the north of and adjoining Tambourah Creek. The whole surface of the lease is occupied by hornblende schist of the usual type, and inclined at very high angles to the east. Two well-defined reefs traverse the

property; it is however only upon the eastern reef, which lies at an average distance of 150 feet from the western boundary of the lease, that any work has been done. A fair amount of prospecting work has been carried out upon this reef, which can be followed by its outcrop for a distance of a little over 500 feet.

A shaft has been sunk somewhere near the centre of the outcrop at a point about 450 feet from the southern boundary of the lease. This shaft is at the present time inaccessible, but from the notes of the late Mr. Inspector Becher, it appears to have been carried down 25 feet, and levels driven north and south from a depth of 20 feet for an unstated length. The same writer states:—"Near the surface in this shaft, very rich specimen stone was found, but was apparently confined to a patch, and the owners do not apparently consider the prospects sufficiently encouraging to continue work."

So far as may be seen on the surface the reef is very thin, in no place exceeding twelve inches; the stone is somewhat ferruginous, suggesting pyrites at a depth.

The files of the *Northern Public Opinion* give the following records regarding three crushings from the World's Fair in 1898, viz. July 2nd, 100 tons for 108ozs., and 98 tons for 208ozs.; whilst on August 20th, 60 tons are stated to have yielded 35ozs. These three crushings total 258 tons for 351ozs., or at the rate of 1·36oz. per ton, which is considerably less than the official return for the year in the following table. It may be noted however that this table gives the aggregate yield of the three leases held by the then World's Fair Gold Mining Company, viz. 254, 255, and 258, so that there are no means of knowing whether the whole of the gold so recorded was actually obtained from the World's Fair Lease, G.M.L. 256.

Table showing the Yield of the World's Fair G.M. Co., Ltd., G.M.L's. 254, 255, 258.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	412·00	505·60	1·22

Golden Cheers, G.M.L. 275.—A very large proportion of the surface of this lease, upon which little or nothing appears to have been done, is occupied by the sandy bed of Tambourah Creek, which in this portion of its course averages about 200 feet in width. There are however strong geological grounds for believing that the Charlie and the World's Fair Reefs may traverse the centre of the lease, but if so the outrop can only be small and ill-defined.

Charlie, G.M.L. 257.—The main Charlie Reef, of which the World's Fair (q.v.) may be the northern extension, extends through the whole length of the lease, outcropping at no very great distance from the western boundary of the property.

Prospecting operations however appear to have been confined to a small reef, the outcrop of which can be seen entering the lease on its southern boundary at a point about 140 feet from the peg forming the south-west angle of the property. An inaccessible shallow shaft has been put down at the southern end of the reef, but there is little or nothing to be seen at the present time.

Federal, G.M.L. 456.—A fair amount of prospecting work appears to have been carried out on two other parallel reefs, which outcrop at average distances of 100 to 200 feet east of the main Charlie Reef, in the ground lying between G.M.L's. 260 and 257, and at one time embraced by G.M.L. 456. Shafts have been sunk upon each of the reefs at localities which are indicated on the Geological Sketch Map, Plate I.; but they are inaccessible, and no information is available at the present time regarding them.

The following table gives the yield of this lease so far as can ascertained from official data:—

Table showing the Yield of the Federal, G.M.L. 456.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898 *	11·00	15·25	1·38

* The issue of the 12th June, 1897, of the *Northern Public Opinion* gives a return for that year of 19·50 tons yielding 21·00ozs., or at the rate of 1·07oz. per ton. It is probable that these figures are included in the official returns from Sundry Claims in 1897.

Eastern Hero No. 1 South, G.M.L. 260.—A six-acre lease adjoining the Young Australian No. 1 North, G.M.L. 341 on the north. A short though well-defined white quartz reef outcrops near the centre of the property at an average distance of about 100 feet from the western boundary of the lease. The reef underlies to the west at a high angle, as is the case with most of the quartz reefs of Tambourah. What may be called the extension of this reef makes its appearance a short distance northwards, where it leaves the lease at a point on the northern boundary distant about 120 feet east from the peg forming the north-west angle of the lease. This reef, which is remarkable for its longitudinal persistence, can be followed northwards right through the Charlie, G.M.L. 257 for a distance of about 1,500 feet.

Young Australian No. 1 N., G.M.L. 341 (formerly Old Australian, G.M.L. 465).—This nine-acre lease adjoins the Young Australia on the north and the Alexandra on the east. Virtually

no work seems to have been done upon the ground. The Young Australia reef enters the lease at the south-west angle of the property, and can be followed to a point about 500 feet north, where the granitic dyke, which traverses the surface, crosses its outcrop almost at right angles to the strike of the reef. North of this dyke a well-defined band of laminated quartzite, with secondary silica, makes its appearance, and can be followed without interruption to the northern boundary of the lease and for a distance of about 800 feet farther.

Table showing the yield of the Young Australian No. 1 N. (formerly the Old Australian, G.M.L. 465).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	51·50	70·10	1·36

Quartz Claim 148 (McGrath & Anderson).—A quartz claim, the exact situation of which is not now identifiable, produced in 1904, 43·71ozs. of gold.

Sundry Claims.—The following figures arranged in a tabular form annually give the yield of the various claims which have been held at different times, but which cannot be located on the map at the present time. It is more than likely that some at any rate embraced the areas covered by the leases referred to in the previous pages.

Table showing the Yield of sundry Claims at Tambourah.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1897	23·00	33·65	1·46
1898	128·75	197·40 *20·00	1·53
1899	436·50	590·95 †50·00	1·35
1900	51·00	89·20 †215·00	1·75
1901	...	†25·00	...
1902	...	*Nil*	...
1903	...	*Nil*	...
1904	...	†43·71	...
1905	...	*Nil*	...
Total	639·25	911·20 *20·00 †333·71	1·42

* Dollied and Specimens. † Alluvial.

THE HON: H. GREGORY M.L.A.
Minister for Mines

GEOLOGICAL SKETCH MAP
OF
TAMBOURAH
PILBARA G. F.

BY
H. Gibb Maitland
GOVERNMENT GEOLOGIST
AND
H. W. B. Talbot
FIELD ASSISTANT

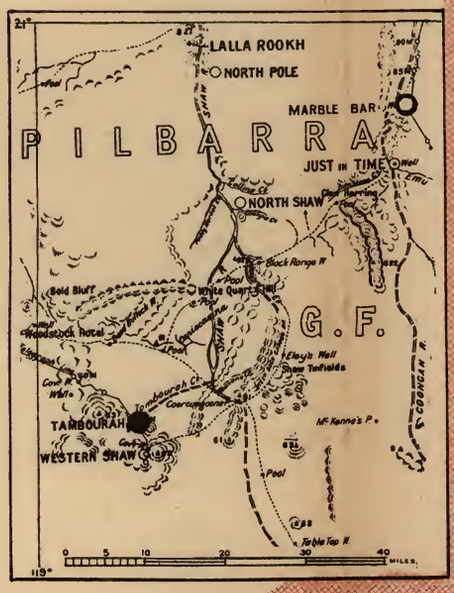
1905

0 10 20 30
Scale of Chains

EXPLANATION OF COLOURS & SIGNS

GRANITE (and its derivatives) ..... Gn
GREENSTONES (" their ") ..... Dil.
QUARTZ REEFS ..... Q.R.
LAMINATED QUARTZ VEINS .....
LINES OF FOLIATION .....
GEOLOGICAL BOUNDARIES .....
EXTINCT MINING LEASES { Name of ..... Corunna / Number of ..... 272 / Boundaries of ..... }
REGISTERED Nº OF SPECIMEN ..... [6488]

LOCALITY MAP.



Gn
Dil.
Schist
Corunna
272
Greenstone Dyke?
Tambourah Queen
262
259
Worlds Fair Nº1. N.
256
Worlds Fair
Hornblende Schist with several small unmapped Quartz Reefs
[6485]
[6486]
264
Duke of Wellington
275
Golden Cheers
Arnastra [6487]
TAMBOURAH CREEK
Gov. Well [6489]
274
267
Charlie
257
Tambourah King Ex.
Western Chief
[6490]
456
Federal
252
[6491]
Tambourah King
260
Eastern Hero Nº1. S.
341
334
255
Young Australian Nº1. N.
Alexandra
Tambourah King Nº1. S.
261
465
Young Australia
Old Australian
Several small unmapped Quartz Reefs
254
Western Hero Nº1 N.
253
455
Western Hero Kushmattie
One Tree Hill

R.H. Irwin del: 13/4/06

H.J. Pether, Government Lithographer, Perth, W.A.

Synoptical Table showing the Yield of the Tambourah Reefs up to the end of 1905.

Name of Reef.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
Brilliant	35·00	21·60	·61
Federal	11·00	15·25	1·38
Kirkpatrick	88·00	208·50	2·36
Kushmattie	140·50	271·65	1·22
Old Australian	51·50	70·10	1·36
P.A.	...	*	
Quartz Claim 148	...	† 43·71	
Sundry Claims	639·25	‡ 1,264·91	1·42
Tambourah King	86·00	154·00	1·79
Tambourah United § ...	34·00	37·68	1·10
Western Chief	654·00	763·90	1·16
Western Chief No. 1 S. ...	102·00	‖ 249·31	1·16
World's Fair	412·00	505·60	1·22
Total	**2,253·25**	**3,606·21**	**1·60**

* Returns probably included under the Western Chief Mine. † Dollied and specimens. ‡ Includes 20ozs. of dollied and specimens and 333·71ozs. of alluvial. § Exact locality unknown. ‖ Includes 130·140ozs from tailings.

General.

An impartial observer cannot fail to be struck with the backward state of the district considering the short period of its existence. The number of shafts in close proximity, upon one of the properties, the Western Chief, seem to imply that prospecting operations were hardly carried out in the most judicious manner and a good deal of unnecessary work was done in consequence.

Firewood and timber for mining purposes are not abundant, but there is little doubt that careful search would result in the discovery of sufficient in the vicinity to meet the requirements of a small field for a few years.

So far as can be ascertained there seems to be a fair water supply to be obtained at a shallow depth, but whether such would prove sufficient to withstand a constant draft upon it, there is no evidence.

B.—WESTERN SHAW.

(With two Geological Sketch Maps, Plates II. and III.)

The mining centre of Western Shaw lies about five miles to the south-east of Tambourah, and like it is situated on the old mail route to Roebourne. At one period of its history, Western Shaw was connected with the main telegraph system of the State. The relative position of Western Shaw is shown on the Geological Sketch Map, Plate III., which also indicates in a general way the situation of the field with respect to the boundary of the intrusive granite, which is continuous from Tambourah.

The backbone of Western Shaw is formed of several parallel rugged and broken razor-backed ridges, which rise to heights about 200 feet above the general level of the country, and form very conspicuous features in the landscape. These ridges trend generally north and south, and it is upon the slopes of the westernmost that the principal prospecting and mining operations have been hitherto carried out.

History.

The history of Western Shaw as a mining centre appears to have commenced with the rush of 1891, and an immense amount of alluvial gold was won by the dryblowers in the many gullies which traverse the country. As a reefing centre however its history dates from 1894, and as has been the case with most of the North-West mining fields, the district has had a somewhat chequered career.

The late Mr. Becher, at one time Acting Inspector of Mines for the Northern Goldfields, in his report to the Government on the district for the year 1894-5, remarks:—

"The Western Shaw, although a field which has been well known for many years for its alluvial gold, is one of the new reefing fields coming quickly to the fore. The general character of the country lying on the outskirts of the granite is most attractive in its rugged nature and geological conditions. Immense quartzite or quartz jasper dykes form the crests of ranges of diorites, opaline, slates, and schists, all having a general uniform bearing or strike slightly west of north. The strata are much upheaved and underlie westwards. Many large well-defined and continuous reefs are to be seen, and a considerable amount of work is being done on good stone. During the year several rich finds have been made." *

In his report for the following year, Mr. Becher states that:—

"At Western Shaw considerable progress has been made by the Imperial West Australian Corporation, who have erected a ten-head battery on their property." †

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* Annual Report of the Department of Mines for the year 1895. Perth: By Authority, 1896, p. 30.

† Annual Report of the Department of Mines for the year 1896. Perth By Authority, 1897, p. 36.

The Warden, in his report on the Pilbara Goldfield for 1906, mentions :—

"A battery is now being erected at Western Shaw, and the few parcels of stone that have as yet been crushed for the battery owners themselves, and for some of the surrounding leaseholders, have yielded good returns and proved the properties to be more than payable." *

In his report for the following year, the Warden mentions that the population of the district amounted to 20 persons, that there were six mining leases in existence totalling 78 acres, and held by one company, and that the gold yield was 1,032ozs., derived from the milling of 1,140 tons of stone. †

No further mention of Western Shaw appears in any later Annual Reports of the Department of Mines.

The field has suffered a gradual decline, until at the present time it is practically abandoned.

General Geological Features.

In its salient geological features, Western Shaw presents many important points of resemblance to the mining centre of Warrawoona. ‡

The geological formations of the area embraced by the Geological Sketch Map, Plate II., are represented by a series of greenstones and greenstone schists, which form the southern extension of those at Tambourah.

To the eastward of the greenstones and in the vicinity of Trig. Station B2, these are succeeded by a series of silky acidic schists, grits, quartzites, and fine conglomerates, which latter have been subjected to considerable dynamic alteration. These beds are vertical, and trend generally north and south. The exact relation which the schists bear to the greenstones has not been worked out.

The greenstones are traversed by dykes of granitic schist [**6491**], which have a general parallelism to the trend of the main structural features of the district.

The rocks of the field are like many other of the north-west mining districts, traversed by veins of laminated quartz. Two of the most important of these have been laid down on the map with a reasonable degree of accuracy. One very conspicuous band traverses the whole length of the area mapped, viz., about $2\frac{1}{2}$ miles, and forms the centre of what may be called the main auriferous zone, which latter is indicated by the long line of leases. The

* Loc. Cit., p. 59.

† Annual Report of the Department of Mines for the year 1897. Perth: By Authority, 1898, p. 24.

‡ Bulletin No. 20, pp. 57-73. Perth: By Authority, 1905.

laminated quartz veins are traversed by faults, one of which has a horizontal displacement of about 600 feet. This fault, which is well marked on the surface, and appears to be a reverse fault, has a general strike of north-west and south-east.

Most of the watercourses in the district are, as may be seen by a reference to the Map, occupied by a varying width of alluvium, some portions of which have been very extensively worked, and, from all accounts, a fair amount of alluvial gold would appear to have been obtained therefrom. So far as has at present been ascertained, the alluvial deposits do not attain any great thickness.

A Government Well has been sunk in the centre of the alluvial flat, a little to the north of the 75-mile post on the old telegraph line, to a depth of 37 feet, and yields a supply of about 400 gallons of good, fresh water per day. There is no information as to the thickness of alluvium in this well.

There are several well-defined quartz reefs in the area under investigation, the longest of which has a continuous outcrop of about 1,200 feet; whilst another to the east is represented by four well-marked veins, connected by thin threads of quartz, may be said to be about 2,500 feet long.

From what can be seen at the present time, the quartz reefs seem to conform to the foliation planes of the schists, etc., and may, perhaps, on that account, be best described as bedded veins. The quartz is generally very white and milky in colour, and is occasionally very honeycombed, due to the decomposition of iron pyrites.

The gold is said to have been very coarse, and, as might have been expected, occurred most plentifully in the honeycombed quartz.

The Ore Deposits and Mines.

No mining work of any description was being carried on at the date of my visit to the district, though such mines as were open to inspection were visited, and full descriptions of them are given below.

When operations were in full swing, seven of the thirteen leases in existence on the field, were held by the Imperial W.A. Corporation, and a considerable amount of development work had been done. In order to facilitate the company's operations, tram-lines of 35 chains and 70 chains in length had been laid down from the leases 214 and 213 to the battery site on the western boundary of G.M.L. 291. For convenience of description the mines and other workings are described in geographical sequence, commencing at the northern end of the field.

Trafalgar, G.M.L. 338 (*vide* Plate II.).—This 12-acre lease is situated about 1½ miles north of the Government Well on the eastern side of the range which forms the main axis of Western Shaw.

Two very small quartz veins, striking north-east and dipping west, had been opened up by trenching; the veins averaged about eight inches in thickness. A vertical shaft 75 feet deep had been sunk, and at 45 feet levels driven 30 feet north and south respectively.

The two reefs mentioned above are stated to have been met with on each wall, and their average thickness proved to be about eight inches. A second shaft had been sunk to a depth of 40 feet at a spot somewhat further to the south, but no particulars concerning it are available.

The quartz of the veins in this lease is stated to have been of a white colour, and contained small quantities of iron and copper pyrites.

The following table gives the yield of this property, so far as such can be obtained from official data :—

Table showing the Yield of the Trafalgar, G.M.L 338.

Year.	Ore treated.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
Prior to 1897	6·00	36·00	6·00
1897 *	24·00	54·00	2·25
Total	**30·00**	**90·00**	**3·00**

* The files of the *Northern Public Opinion* for June 5th, 1897, give the yield as being 24 tons for 83ozs., or at the rate of 3·46ozs. per ton.

Pink Eye, G.M.L. 340.—A 12-acre lease lying some little distance to the south of that last described is traversed by four short, but well-defined, quartz veins encased in a talcose and chloritic schist. The westernmost reef, which is by far the longest of any, having a length of about 450 feet, is the one upon which most work has been done. Two vertical shafts, connected by a drive at 40 feet, have been sunk to depths of 50 and 40 feet respectively upon the reef, which is stated to have attained an average thickness of about 1 foot 6 inches, and dipping at a high angle to the east. At the time the mine was at work and visited by the then Inspector of Mines, Mr. Becher, there were about 150 tons of ore at grass awaiting crushing. No official record, however, is available of the yield of the stone, which is in all probability included in that of Sundry Claims from the Tambourah district district, given on a previous page.

The Imperial W.A. Corporation, Ltd, London.—

Gold Mining Leases ... 291, W. Shaw No. 1 N.
214, W. Shaw Reef.
290, W. Shaw No. 1 S.
428, General Gordon No. 1 N.
230, General Gordon.
215, W. Shaw Consolidated.
213, W. Shaw Extended.

Western Shaw Reef, G.M.L. 214.—The principal workings on this 12-acre lease have been carried out on two short parallel veins, which outcrop near the summit of the hill on the eastern boundary of the property. These two reefs have outcrops about 200 feet in length, and lie about 20 feet apart. The reef had been worked by a tunnel driven on a bearing of 59 degrees 30 minutes from near the base of the western side of the range. The total length of the tunnel is 262 feet, and struck the reef at 200 feet from its mouth; the first few feet in the tunnel expose what appears to be a compressed greenstone, which, however, gradually gives place to the normal rock. From the tunnel, drives have been carried 103 feet north and 80 feet south respectively. The reef averages about 12 inches in thickness, and in the southern drive proved to be very large in places. The quartz of the reef is of a characteristic white colour, and carries a certain amount of gold on the casing. The tunnel has been carried 62 feet eastward beyond the reef, and ends in a small laminated quartz vein dipping to the westward at an angle of 70 degrees. An underlay shaft 95 feet in depth has been sunk at a spot indicated on the Geological Map, Plate II., and connects with the drive to the north of the tunnel. A considerable amount of stoping has been done on the reef, so far as may be judged by the present condition of the workings. Very rich specimen stone is said to have been of frequent occurrence in the mine. A tramway had been laid from the tip at the mouth of the tunnel to the battery.

To the west of this lease, and between it and the alluvial flat on the main creek, are five quartz reefs, upon which, judging from the condition of the surface, a fair amount of prospecting work must have been done; there is, however, no information as to the results of this.

Western Shaw No. 1 South, G.M.L. 290.—The centre of this lease is traversed by a persistent vein of laminated quartz, which extends over the whole length of the leases; whilst the south-western portion is occupied by the wide alluvial flat, which has yielded such large quantities of gold in the early days of the field. The south-west angle of the ground is occupied by a well-marked quartz reef, which trends north-west and dips west at a high angle. This reef abuts against the reverse fault, which traverses the adjoining lease to the south.

THE HON. H GREGORY M L A.
Minister for Mines.

GEOLOGICAL SKETCH MAP OF WESTERN SHAW

PILBARA G.F.

BY

A. Gibb Maitland
GOVERNMENT GEOLOGIST
AND
H. W. B. Talbot
FIELD ASSISTANT

1905

0 10 20 30 40
Scale of Chains

EXPLANATION OF COLOURS & SIGNS

- ALLUVIUM ..... ~
- GREENSTONE (and its derivatives) ..... Dil
- GRANITIC SCHIST ..... Gnl
- QUARTZ REEFS ..... Q
- LAMINATED QUARTZ VEINS ..... L.Q.R.
- FAULTS ..... f
- GEOLOGICAL BOUNDARIES ..... (Where doubtful.)
- EXTINCT MINING LEASES
  - Name of ..... Pink Eye
  - N° of 340
  - Boundaries of .....

LOCALITY MAP

R H Irwin del 23/4/06

H J Pether, Government Lithographer, Perth W.A.

General Gordon No. 1 North, G.M.L. 428.—A small six-acre lease, adjoining the one previously described on the south. The important structural feature of this lease is the reverse fault, which traverses its whole extent in the position indicated upon the Geological Map, Plate II. The quartz reef, which enters the property on the north at a point about 130 feet from the north-western angle, turns sharply southwards on approaching the fault, against which it is abruptly truncated. A tunnel has been put in for a total distance of 72 feet, on the following bearings:—210 degrees, 48 feet, and 245 degrees, 24 feet; 31 feet from the mouth of the tunnel the reef was met with, but disappears a few feet at the fault. The late Mr. Inspector Becher, who sampled the reef, stated in his official report that it did not yield good prospects. An excellent view of this reverse fault, and the curving of the foliation (? bedding) planes in its proximity, is to be obtained from the rising ground to the east of the creek on the eastern boundary of the lease.

General Gordon, G.M.L. 230.—This 12-acre lease adjoins that last described. The centre of it is traversed by the laminated quartz, with which are associated a few irregular veins of quartz. The original prospectors are stated to have obtained some good coarse gold from the outcrop of one of these veins outcropping on the steep slopes of the hillside. On the summit of the hill and to the east of the belt of the laminated quartz, a very small rich patch of alluvial (residual) gold was met with. The patch was only a few feet square, and occurred in close proximity to one of the thin irregular quartz veins, to the disintegration of which the origin of the gold is to be ascribed. A shaft has been sunk to a depth of 44 feet on a vertical quartz reef, and a crosscut driven 21 feet west, but these were inaccessible. A tunnel has been driven into the side of the hill for a distance of about 160 feet at a point some distance to the south of the shaft described, but it also was inaccessible; it is, however, asserted to have been driven to no purpose.

Western Shaw Consolidated, G.M.L. 215.—This is a 12-acre lease, which adjoins the General Gordon on its southern boundary; the property is traversed throughout its whole length by the belt of laminated quartz which forms the summit of the ridge upon which the property is situated.

Near the northern boundary of the lease, at a point shown upon the Geological Sketch Map, Plate II., is a quartz reef of from six to eight inches in thickness; this, which underlays east at an angle of 47 degrees, has been opened out to a depth of about 12 feet. The quartz, which is of the characteristic white colour, gradually diminishes in thickness from the surface to the bottom of the shaft, at which point it is abruptly cut off by a strike fault.

The main reef, which has been opened out in the adjoining lease to the south, traverses the southern portion of the property

for a distance of about 300 feet north of the southern boundary, at which point it appears to peter out on the surface. This main reef has been worked by means of two shafts and a tunnel, put in along the boundary of the two leases, in an easterly direction, near the base of the hill on the western fall of the ridge upon which the reef outcrops. The tunnel, which intersects the reef at 58 feet from its mouth, shows the following section:—Schist, 27 feet; laminated quartz, 16 feet; and schist, 15 feet. The main reef at the tunnel is six inches in thickness; it has been exploited by a drive which has been carried north along the reef for a distance of 300 feet. The reef, wherever seen, averages about 18 inches, although in isolated places it attains a thickness of over four feet. At a point distant 164 feet north from the face of the tunnel, a shaft 60 feet in depth, sunk on the reef the whole way, connects with the surface; whilst a second shaft of 75 feet intersects the drive at 260 feet from the tunnel. In this shaft a level has been driven on the reef 83 feet north from a point 40 feet below the mouth of the shaft, but such was inaccessible to me.

At a point near the western boundary of the lease, and about 440 feet from the northern boundary, is a tunnel, which has been driven westward and connects with a shallow vertical shaft adjoining the old tram-line. The workings, however, were inaccessible to me.

Western Shaw Extended, G.M.L. 213.—This 12-acre lease is the most southerly of the group owned by the Imperial W.A. Corporation Co., Ltd. The surface of the lease is occupied by greenstones and their cleaved and foliated derivatives. The centre of the property is traversed from end to end with the laminated quartz, which forms the main axis of Western Shaw. It dips west at an angle of 75 degrees. The main reef enters the property on the northern boundary, and can be followed southwards for a distance of 900 feet, the southern end of it being represented by a mere thread of quartz. The reef has been opened from the tunnel alluded to in the description of the adjoining lease on the north. From the face of the tunnel a drive had been carried south for a distance stated to be 300 feet. This was, however, inaccessible to me for a distance of 253 feet. An air-shaft 30 feet in depth connects with the surface at a point 30 feet south from the face of the tunnel, and a second, 70 feet in depth, at 153 feet from the same spot. The reef is showing for the whole length of the drive, and, although it varies greatly in thickness, it may be said to average about 18 inches. The quartz of which the reef is made up is almost pure white; it carries a little iron pyrites, galena, and more or less coarse gold. The original prospectors of the reef are stated to have obtained very good specimen stone along the outcrop, which may be held accountable for the amount of surface work done upon it. A large quantity of quartz obtained from the reef is lying at the mouth of the tunnel, and was not put through the battery by the owners of the property.

The Hon H Gregory M L A
Minister for Mines

GEOLOGICAL SKETCH MAP
OF
TAMBOURAH & WESTERN SHAW
PILBARA G F

BY

A. Gibb Maitland

GOVERNMENT GEOLOGIST

AND

H W B Talbot

ASS'T. GEOLOGICAL ASSISTANT

1905

Scale of Chains

0 40 80

EXPLANATION OF COLOURS AND SIGNS

ALLUVIUM

GRANITE

GRANITIC SCHIST

GREENSTONE (and its derivatives)

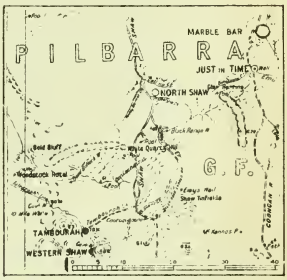
METAMORPHIC GRITS, FINE CONGLOMERATES &c

QUARTZ REEFS

LAMINATED QUARTZ VEINS

FAULTS

GEOLOGICAL BOUNDARIES



H. J. Pether, Government Lithographer, Perth, W. A.

The following table gives the yield of the Imperial West Australian Corporation's property, so far as can be deduced from official data:—

Table showing the Yield of the Imperial West Australian Corporation, Ltd., G.M.Ls.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
Previous to 1897	18·50	19·00	1·02
1897*	1,190·50	1,060·89	·89
1898	12·00	34·65	2·89
1900	...	†31·75	
Total	1,221·00	1,114·54 †31·75	·91

*The issues of the *Northern Public Opinion* of January 16th, February 20th, and June 5th of 1897, give the following detailed returns for that year:—

Month.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
January	140·00	522·00	3·72
February	80·00	253·00	3·16
June	240·00	474·00	1·97
Total	460·00	1,249·25	2·71

†From tailings.

General.

So far as can be ascertained from the official figures, the following table gives the gold yield of this centre, other than that derived from the alluvium, of which there does not appear to have been any separate record, such alluvial gold as has been obtained having probably been included under the general yield of the whole of the district as defined by the authorities.

Synoptical Table of the Gold Yield of the Western Shaw Reefs.

Name of Reef.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
Imperial Leases	1,221·00	1,146·29	·91
Trafalgar	30·00	90·00	3·00
Total	1,251·00	1,236·29	·98

There is very little firewood within the vicinity of the mines; whilst timber for mining and building purposes would have to be carted at least 20 miles. There is no battery for crushing the stone which might be raised from any of the reefs.

C.—NORTH SHAW.

(With a Map, Fig. 2.)

No opportunity of visiting North Shaw presented itself, but in order that this and the two previous reports may contain information respecting every locality where mining operations are being or have been carried out, the following unpublished description by the late Mr. S. J. Becher, at one time Inspector of Mines for the district, are included.

So far as can be ascertained, the total gold yield in fine ounces of this centre has been, up to the close of 1905, as follows :—

Alluvial	...	...	...	7·53ozs.
Dollied	...	...	...	567·06 „
			in addition to	674·72 „ the result of the milling of 351·45 tons of ore.

"The North Shaw district lies to the south west of Marble Bar, 36 miles by horse track or 40 miles by road. The workings lie to the south of the Callina Creek about two miles from the junction of Callina Creek and Shaw River.

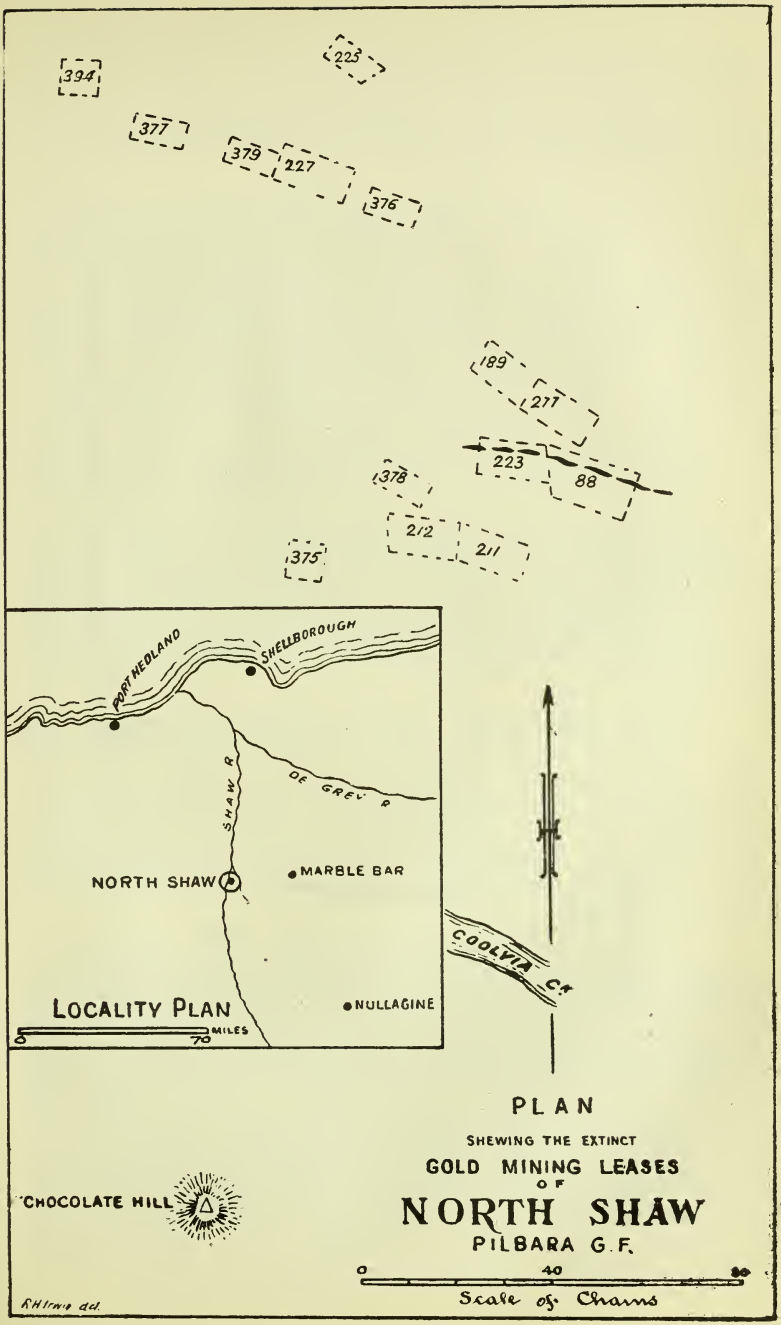
"Low hills and an extensive flat contain the reefs now being worked; most of the reefs only show their line of outcrop here and there, the main exception being the Leviathan line, which is a big white quartz reef outcropping boldly for a couple of miles.

"There is an abundant supply of good timber, and several permanent pools and soaks in the river beds. A Government Well has been sunk on the flat near the Callina Lease. The country is kindly. The reefs mostly carry a lot of mineral (copper, iron, and some galena and silver ores). In the old Leviathan very coarse gold has been obtained, but most of the gold in the mineralised quartz is of a fine nature.

The Mines.

"Eldorado, G.M.L., 88.—Situated about ¾ of a mile from Government Well. This is the oldest mine of the place, having been worked for over two years by various parties. The line of reef does not outcrop consistently, only showing here and there on this and the adjoining (west) lease. Upon this lease it is bigger than elsewhere, being in places quite six or seven feet wide. The stone is mineralised with iron, copper, and silver ores and the quality of the gold is low in value. Some handsome specimens have been obtained, and a trial crushing of 4 tons gave a return of 7ozs. per ton. A considerable amount of work has been done, but the property became liable to forfeiture owing to the non-compliance with the labour covenants by the Eldorado G.M. Co. of Melbourne. The reef is practically vertical, with perhaps the least underlay south, the course being east and west. A vertical shaft has been

FIG. 2.


394
225
377
379
227
376
189
271
223
88
378
212
211
375
PORT HEDLAND
SHELLBOROUGH
SHAW R.
DE GREY R.
NORTH SHAW
MARBLE BAR
NULLAGINE
LOCALITY PLAN
0
70
MILES
COOLVIA Ck.
CHOCOLATE HILL
PLAN
SHEWING THE EXTINCT
GOLD MINING LEASES
OF
NORTH SHAW
PILBARA G.F.
0
40
80
Scale of Chains
R.H.Irwin del.

sunk 60 feet and levels driven at 30 feet and 60 feet. There is now 25 feet of water in the shaft; was therefore unable to examine lower level. At the 30 feet level, in a short drive of 18 feet west, the reef apparently pinches out but should make again. Eastward a drive of 40 feet connects with No. 2 shaft, a big body of stone being driven on. The drive is carried on eastward some 30 feet on the reef. Some tons of stone at grass. Should the forfeiture be approved, a battery will at once be erected.

"Eldorado West, G.M.L. 223.—Royer, Quinn, and Haste; 12 acres. Two men; partial exemption. Situated west and adjoining the Eldorado (late). The reef is smaller than in the Eldorado, but yields good stone all through. It retains its steepness and mineralised character. Some of the stone carrying iodargyrite and proustite shows beautiful free gold. Native silver has also been found in this line of reef. The eastern shaft is 33 feet in depth and a drive is being put in westwards towards No. 1 shaft. The reef averages two feet in width with good walls. No. 1 the western shaft, about 50 feet away, is down 40 feet. A short drive of 12 feet has been made eastwards at the 33 feet level to connect with drive from No. 2 shaft. A short drive has also been made west. About 100 tons at grass awaiting crushing. Upon the hillside (south) above the main line of reef, two other parallel lines of reef have been prospected superficially, yielding encouraging prospects. These reefs apparently underlay north at an angle of about 60 degrees, and should therefore meet the main line in depth. The country is diorite or metamorphic schist on both walls.

"The Bertha, G.M.L., 431, 12 acres (W. McPhee).—A newly taken up lease, situated adjoining Eldorado. The reef, which is apparently of considerable width, is a cross line to the Eldorado line of reef, having a north and south course and underlaying east. The stone exposed in a 10 feet hole on the underlay is of encouraging character, and is mineralised with lead and iron ores. In washing dish prospects, carbonate of lead remains as a fine residue occasionally.

"Auraria, G.M.L., 394, six acres (Wm. Wye).—Situated on the plain about $\frac{3}{4}$-mile west of the Government Well, $\frac{1}{2}$-mile from Callina Creek and $1\frac{1}{2}$ miles from junction of Callina Creek and Shaw River. The reef outcrops only here and there, but the line is marked. Prospecting trenches have been sunk exposing a well defined reef of 12 inches to two feet. A shaft is down 46 feet on the underlay, the reef having an east and west course and underlaying north at an angle of 65 degrees. The walls are true and consist of an altered slate hanging wall country with porphyritic intrusions and a metamorphic schist footwall country, very hard. The shaft is well propped and has good ladders. The stone is mineralised with iron and a little copper. Average sample from ore stack gave $1\frac{1}{2}$ ounces prospect.

About 20 tons at grass. Stone from reef exposed in prospecting trenches gives prospects of about one ounce.

"Struck Oil, G.M.L. 375, six acres (W. Wye).—Situate about three-quarters of a mile south-west of Eldorado. Course of reef (inconsistent) east and west, underlay slightly south. Shaft (vertical) sunk 30 feet. At 15 feet level reef cut right off horizontally, apparently faulted across from south side. Short crosscut shaft failed to pick up. At bottom level, drive 13 feet, but no reef. Stone highly mineralised and prospecting well; trenched in other places. Consider it to be only a superficial small gash vein.

"Nil Desperandum, G.M.L. 378, six acres (Wye and Walker).—Situated due west of Eldorado West, about half-a-mile distant. A small very highly mineralised (copper) reef of about 8 inches to 18 inches outcrops flatly around the base of low hill; probable course east and west, and underlay north. A general sample yielding 2ozs. prospect. A little trenching done. Another parallel reef outcrops on hill side; similar stone. Shaft (underlay) just commenced where stone is about 12 inches to 18 inches in thickness. Good prospect.

"General.—A boldly-marked line of reef some 2 feet to 12 feet in thickness, and extending for a couple of miles, lies parallel to and south of the Eldorado. It is known as the Leviathan, from the name of two abandoned leases taken up formerly on the west end, where a rich patch of some 500ozs. of gold or more was worked out, and where, around the reef, some rich alluvial had been obtained. The reef is mostly of very white quartz. A small shaft was put down on the old Leviathan lease area, but nothing is now being done on this line of reef."

D.—JUST-IN-TIME.

(*With a Geological Sketch Map, Plate IV.*)

The mining centre of Just-in-Time, which was the scene of a great rush in 1892, is situated about eight miles south of Marble Bar, on one of the tributaries of the Coongan River; its position in relation to the other mining centres is indicated on the geological sketch map of the Pilbara goldfield, which forms the frontispiece to this report.

Although the gold yield of Just-in-Time has been small, considerable interest attaches to the locality on account of the resemblance of its auriferous deposits to the gold-bearing conglomerates of Nullagine, which have been fully described in a former report.*

* Geol. Surv. Bulletin 20. Perth: By Authority: 1905, pp. 12-52.

General Geological Features.

The locality upon which operations have been principally centred is upon the slopes and summits of a relatively narrow and conspicuous ridge which trends generally north-west and south-east.

In its general features there are two distinct geological formations (in addition to the recent superficial accumulations) in the district, viz:—

(*a.*) an older series of schists and allied rocks, and

(*b.*) a series of grits, quartzites, sandy shales, and conglomerate, together with bedded lavas, the whole being the equivalent of the Nullagine series, which is so extensively developed in the North-West Division of the State.

The schists and allied rocks form part of the zone which embraces Yandicoogina, Warrawoona, Marble Bar, and Talga Talga, which have been fully described in former reports*. The schists as developed in the vicinity of Just-in-Time were not examined in any detail; they were found, as was the case elsewhere in the district, to carry quartz reefs, which, however, did not appear to be of any great extent.

Approaching Just-in-Time from the south-west, by way of Cooglegong, a complete section of the Nullagine Series is obtained. The beds in this locality cover a width of about 21 miles on the surface.

After leaving the granite, which forms the staple formation from Cooglegong to the Black Range Well (Geological Sketch Map of Pilbara—Frontispiece), a coarse conglomerate or boulder bed makes its appearance in the bed of the river at the crossing. The conglomerate contains large boulders of granite of the Cooglegong type. From the Black Range Well the road to Just-in-Time trends generally north-east, and traverses grits, etc., with occasional relatively small patches of granite and schists, which the irregularity of the floor upon which the Nullagine Beds were laid down causes to rise to the present surface of the ground and protrude through the newer beds. Some distance from the old Black Range Well, and a little distance from the new well, which had recently been sunk, and the position of which is not indicated upon any of the published plans, the sedimentary rocks give place to vesicular lavas, etc., of the type common to the series elsewhere. At Glen Herring, a very coarse conglomerate and quartzite, dipping at 45 degrees to the north-east, makes its appearance in the lofty ranges which abound in the vicinity. The conglomerate at the base is made up of pebbles and boulders of the jaspideous quartzite, which forms the picturesque band of rock at Marble Bar.†

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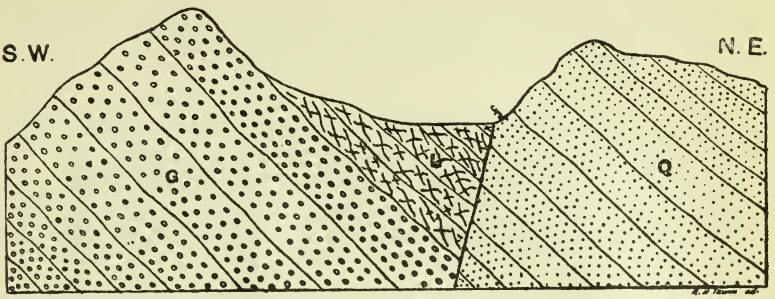
* Geol. Surv. Bulletin 15. Perth: By Authority: 1904, pp. 44-51, 61-72; and Geol. Surv. Bulletin 20. Perth: By Authority: 1905, pp. 57-105; 105-120.

† Geol. Surv., Bulletin 20. Perth: By Authority: 1905, p. 107.

In the Gorge at Glen Herring the conglomerate was seen to be overlaid by lavas, etc., which were faulted against the quartzite as shown in Fig. 3.

Fig. 3.



Section at Glen Herring Coongan River Pilbara G.F.

G *Conglomerate* Q *Quartzite* L *Lavas* f. *Fault*

As careful an examination of the Glen Herring section as the short time at my disposal admitted, suggested the possibility of the conglomerate being the base of the Warrawoona Beds, though it must be admitted that there is little either for or against that view. From Glen Herring to Just-in-Time, the whole country in the vicinity of the route is occupied by the lavas and associated sedimentary rocks of the Nullagine Series.

At Just-in-Time itself, as may be seen by an inspection of the Geological Section (which is upon the same scale as the map), the Nullagine Series is represented by about 350 feet of grits, quartzites, sandy shales, and conglomerate, together with a great thickness of bedded lavas. At the base of the series, and resting upon the older rocks, is a very ferruginous conglomerate [6496] which varies from an inch up to 5 feet 6 inches in thickness.

In many respects the auriferous conglomerate resembles the ferruginous bands which form such an important feature in the series as developed at Nullagine itself. The conglomerate consists mainly of boulders and rounded and subangular fragments of the neighbouring underlying rocks, together with occasional pebbles of a pre-existing conglomerate. The matrix of the conglomerate is very hard and siliceous, due to the deposition of secondary silica, etc. Certain portions of the conglomerate [6496] contain a sufficient quantity of hematite and limonite, in the form of the cube, the octahedron, and the dodecahedron, to give a distinctive character to the rock. Some of the faces of the crystals are striated in the manner common to pyrites. The iron ore is virtually confined to the thin lenticular bed at the base of the series, though a very small quantity occurs in the stratum, on a higher horizon at the mouth of the tunnel in G.M.L. 114. A portion of the very ferruginous conglomerate [6496] yielded, as the result of an assay in the Survey

Laboratory, merely a trace (*i.e.* less than half a pennyweight) of gold per ton. Though a careful search was made, no free gold could be detected in any of the conglomerate at present open to examination.

The late Mr. Inspector Becher, who visited the district in 1896, when active operations were going on, makes the following important observations:—

"The lode 'freezes' very tightly on to the walls, and as the best gold is found near and on the footwall, a few inches of footwall is taken out with the ore in order not to miss any gold; in fact I have seen a specimen showing gold in the footwall stone taken from a few inches into it, away from the lode. . . . The gold occurs as waterworn particles and grains sometimes attaining as much as several ounces in weight."

This latter observation is of interest and importance in that it would seem at first sight that some at any rate of the gold in the conglomerate is of a detrital character and origin. It is of course conceivable from the nature and mode of formation of the conglomerate that a certain quantity of detrital gold may occur in it, but from the fact that many of the crystals and fragments of the iron ore occur in a more or less rounded form, I am inclined to the belief that the rounding of the gold also is due to other causes than attrition, and that it is of secondary origin. The conglomerate must have been of such a nature as would readily permit of the more or less free circulation of mineral-bearing solutions, whilst the underlying schists are practically impermeable.

The occurrence of secondary gold in the zone of decomposition of the bed rock, upon which the auriferous detrital deposits rest, has already been noted in another portion of the State.*

The auriferous conglomerate at the base of the series, however, is not of any very great horizontal extent, nor so far as can be seen in the workings does it appear to penetrate to any considerable depth. It forms in fact a lenticular bed of somewhat local occurrence, which, from its present position, was evidently deposited upon a very uneven surface. The conglomerate occurs in a local depression on the surface of the underlying rocks, for the bottom can be seen rising to considerable altitudes above the level of the bed exposed near the western angle of what is shown on the geological map as McDonald's Claim.

The creek and its tributaries, which takes its rise in the escarpment of the conglomerate and flows across what was originally G.M.L. 164, has been the scene of some vigorous prospecting. This creek is stated to have yielded a fair quantity of alluvial gold, of which unfortunately there appears to have been no separate record kept. The amount derived from this source is probably included in the returns showing the yield of the Marble

* Annual Progress Report of the Geological Survey for the Year 1899. Perth: By Authority: 1900, pp. 9 and 43.

Bar district as defined by the Mines Department. Most of the gold from this source owed its origin to the disintegration of the conglomerate itself.

The sedimentary beds of Just-in-Time are covered, as may be seen by the Geological Sketch Map and Section, by a considerable thickness of andesitic (?) lavas [**6498, 6499**], many beds of which are vesicular and amygdaloidal. In their general character and behaviour, they agree very closely with those which are exposed in the river for some miles above the township of Nullagine.*

No volcanic focus from which these lavas emanated was noticed within the small area examined. The beds, however, cover a very wide extent of country in the vicinity of Just-in-Time, and it is quite possible that much more detailed search than has at present been carried out would lead to the discovery of the source from which these beds were derived.

The Mines.

No work of any description was being carried on at the date of my visit, and operations had evidently ceased some years ago; nevertheless all the accessible workings were visited and carefully inspected. For descriptive purposes it is convenient to deal with the various workings within the boundaries of the leases existing at the date operations were in full swing; the positions of these are shown upon the Geological Map, Plate IV.

It may be noticed that the nomenclature of the properties leaves very much to be desired in that two distinct leases have been registered under one name, a condition of affairs which is confusing and apt to mislead. A similarity in nomenclature in the case of certain leases at Nullagine has been previously noticed.†

Just-in-Time, G.M.L. 114 (later on, The Great Cement Lode, G.M.L. 251). This six-acre lease was applied for by Messrs. Dunsford and Hogan in 1894. The northern half of the property is occupied by the older crystalline rocks, and the remainder by the sedimentary beds of the Nullagine Series.

The only work done upon the property appears to have been a tunnel driven 48 feet on a bearing of 41 degrees, in that portion of the lease indicated on the map. The tunnel itself has been carried through grit, which dips at an angle of about 35 degrees in a direction of south 50 degrees west. At the mouth of the tunnel is a bed of conglomerate [**6497**] about two feet in thickness, of a somewhat similar type to that which forms the base of the series in G.M.L. 165, but not nearly so ferruginous.

Just-in-Time, G.M.L. 155 (includes Lady Dorothy, G.M.L. 103).

This 21-acre lease, which includes the G.M.L. 103 (known as the Lady Dorothy), was applied for in January, 1895, and a considerable amount of work had evidently been done upon it.

* Geol. Surv. Bulletin 20. Perth: By Authority: 1905, pp. 23, 24 and 26, 27.
† Geol. Surv. Bulletin 20. Perth: By authority: 1905, pp. 38 and 39.

The old six-acre lease the Lady Dorothy was applied for by Messrs. Banger & Church in 1894, and was eventually merged into the larger one.

A tunnel 79 feet in length has been driven on a bearing of north 60 degrees east for a distance of 79 feet to the foot of an underlay shaft, 26 feet in length, which connects with a vertical one 20 feet in depth, Fig. 4. The section in the tunnel comprises a

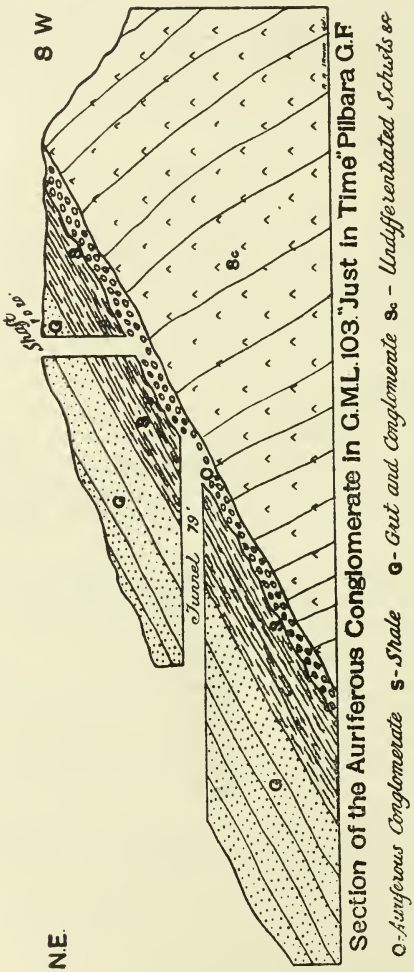


Fig. 4.

bed of conglomerate and grit, which is overlaid by a bed of fine sandy shale, which occupies about 20 feet of the tunnel, starting from the centre of the drive at the face. From the face of the

tunnel, a drive has been put in along the conglomerate for a distance of 136 feet. At the face of the drive, the old floor of the underlying crystalline rocks has risen to the roof of the drive and exposes barely an inch of fine conglomerate or grit. The maximum thickness of the basal auriferous conglomerate in the drive is five feet six inches. Twenty feet from the mouth of the tunnel in this drive a winze has been sunk for a distance of 48 feet on the conglomerate, which dips at an angle of from 20 to 25 degrees; at the bottom of the winze is about five feet of a boulder conglomerate, many of the boulders being from 12 to 18 inches in diameter. A drive has been put in north-west from the face of the tunnel, but it proved to be absolutely inaccessible. Between the drive at this level and the surface, there is an intermediate one of considerable length, but it proved to be inaccessible unless at some considerable personal risk.

At a point (1) on the map an attempt has been made to open out the conglomerate, the base of which is a somewhat higher level than that at the main shaft. The section where prospecting operations had been commenced showed the following:—Conglomerate, 20 feet; sandy shale, 5 feet 2 inches; ferruginous conglomerate [6496], 2 feet 4 inches; the whole resting upon the older crystalline rocks. A sample of this on assay in the official laboratory proved to be appreciably auriferous.

A main water shaft had been carried down to a depth of 154 feet, and judging by the material lying in the dump, bed rock must have been reached. This well, which is stated to have cost £1,000, yielded good water, but not in sufficient quantity for battery purposes. There are unfortunately no data available which indicates the depth at which the base of the sedimentary series was met with in the water shaft.

Just-in-Time Extended, G.M.L. 164.—This twenty-acre lease was applied for by Mr. J. A. S. Roe in 1895; this area comprised the old alluvial ground, upon which a good deal of work has been done, and which it was at one time intended to sluice. The lease however become void in December, 1897.

A fair amount of prospecting work has been done at different points on the face of the escarpment of the conglomerate, which sweeps round the face of the hill.

At a point (2) on the map the conglomerate, which was four feet thick, was worked from the surface to the vertical shaft, which is stated to have cut the bed at 35 feet from the surface. From the foot of the vertical shaft, the conglomerate is stated to have been followed down on the dip for a distance of 40 feet, and a good deal of it stoped out. These workings however were inaccessible.

The conglomerate is overlaid by a fine-grained and drab-coloured sandstone or sandy shale, which was also intersected in the vertical shaft.

General.

The following table shows the yield of the auriferous conglomerate, so far as such can be obtained from the returns of crushings furnished to the Government:—

Table showing the Yield of Auriferous Conglomerate from the Just-in-Time G.M's., Ltd., G.M.L's. 155, 164/5.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
Prior to 1897	30·00	45·00	1·50
1897	25·00	1·40	·05
1898	5·00	·90	·18
Total	**60·00**	**47·30**	**·78**

There is unfortunately no separate record of the gold which has been obtained from the "alluvial ground" on the face of the escarpment.

The occurrence of an auriferous conglomerate, in the same stratigraphial series, at least 50 miles distant from Nullagine where identical geological conditions prevail, would seem to encourage efforts in the direction of carefully prospecting other portions of the basal members of the series, which occupy such an extensive area in the north-west district.

E.—THE WODGINA TINFIELD.

(With a Geological Sketch Map, Plate V.)

The Wodgina Tinfield is situated on the headwaters of the western branch of the Turner River, and within the limits of the Pilbara Goldfield as defined by the authorities, about 74 miles from Port Hedland, and 15 miles due east of the Yule River, which marks the boundary between the Pilbara and West Pilbara Goldfields.

Tin appears to have been first officially recorded from this field by the Warden during the year 1902. Since that date stimulus has been given to prospecting in the vicinity, and during 1905 considerable activity manifested itself at Wodgina in the number of mining leases which had been pegged out. An important find of tantalum ore at Wodgina resulted in a considerable influx of population, but the excitement which this find made rapidly abated with the heavy fall in the market value of the metal.

In addition to the discoveries at Wodgina proper, three leases have been worked at what is known as the Stannum, about eight or

165

THE HON H. GREGORY M.L.A
Minister for Mines.

EOLOGICAL SKETCH MAP

OF

JST IN TIME

PILBARA G. F.

BY

A. Gibb Maitland
GOVERNMENT GEOLOGIST
AND
H. W. B. Talbot
Field Assistant
1905

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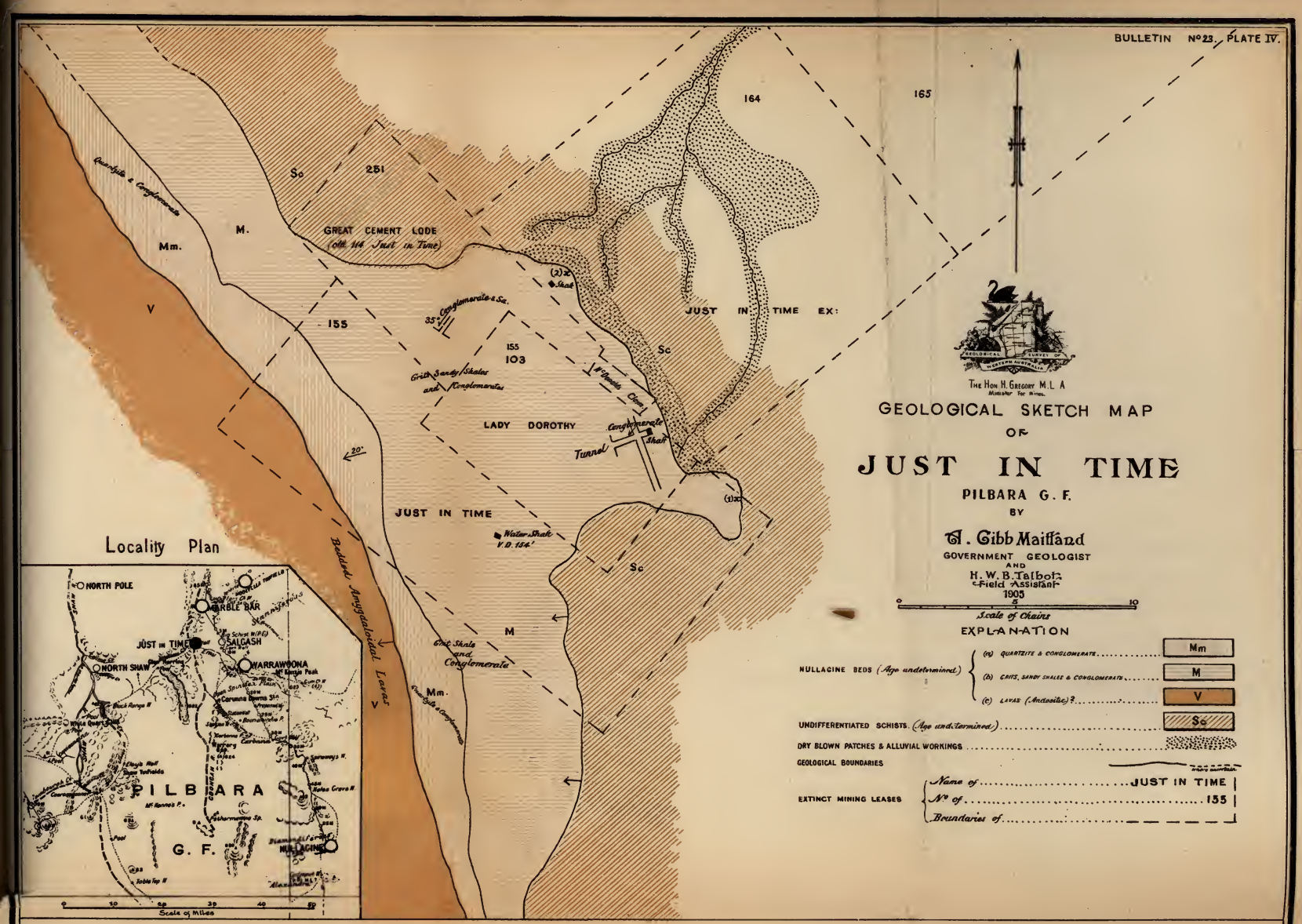


THE HON H. GREGORY M.L.A
Minister for Mines.

GEOLOGICAL SKETCH MAP OF JUST IN TIME

PILBARA G. F.

BY

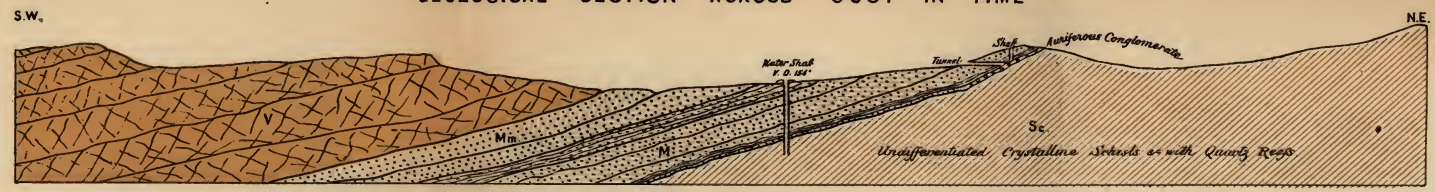
A. Gibb Maitland
GOVERNMENT GEOLOGIST
AND
H. W. B. Talbot
Field Assistant
1905

Scale of Chains
0 5 10

EXPLANATION

NULLAGINE BEDS (Age undetermined)	(a) QUARTZITE & CONGLOMERATE	Mm
	(b) GRITS, SANDY SHALES & CONGLOMERATE	M
	(c) LAVAS (-Andesite)?	V
UNDIFFERENTIATED SCHISTS. (Age undetermined)		Sc
DRY BLOWN PATCHES & ALLUVIAL WORKINGS		
GEOLOGICAL BOUNDARIES		
EXTINCT MINING LEASES	Name of	JUST IN TIME
	Nº of	155
	Boundaries of	

GEOLOGICAL SECTION ACROSS JUST IN TIME



NOTE.—— THE LETTERS AND COLOURS ARE THOSE WHICH CHARACTERISE THE DIFFERENT FORMATIONS ON THE MAP.

R. H. Irwin del. S. G. 05.

H. J. Pether, Government Lithographer, Perth, W. A.

nine miles to the south, upon the same range. This little group has, according to the official figures, produced 6·20 tons of tin during the short period which has elapsed since its discovery.

The total output from the whole of the Wodgina district has, according to the figures available up to the close of the year 1905, been 31·45 tons of tin valued at £2,462, and of tantalite 70·95 tons of the estimated value of £8,925. There are good reasons for the belief that the tin yield disclosed by these figures does not represent the total yield of Wodgina, for tin buyers apparently only commenced reporting their purchases towards the close of 1905.

General Geological Features.

Geologically the district consists of a series of metamorphosed, sedimentary, and igneous rocks, the age of which has not been determined. These rocks skirt a very extensive granite mass, which, as may be seen by an inspection of the Geological Sketch Map (frontispiece), occupies a very large area of country.

These bedded rocks are very much folded and faulted, and upon the whole have a prevailing dip to the west; they occupy a very rugged range, which rises to considerable altitudes above the level of the surrounding plains. These rocks are pierced by granite and pegmatite veins (offshoots from the mass previously described) which invariably occur in intimate connection with the tin and tantalum ores. The occurrence of these pegmatite veins is of considerable economic importance because all the known lode tin deposits occur in association with them. These veins have been mapped in some detail both at Wodgina and Stannum. The geological maps of these two centres should afford a valuable guide to those engaged in mining operations on the field.

Whatever may be the geological age of the main mass of the strata exposed at Wodgina, the intrusive granite is of decidedly later date than the folding, etc., which the bedded rocks have undergone, for neither the granite nor its offshoots have suffered any dynamical alteration since their injection.

So far as has at present been observed, what may be called the tin belt of Wodgina is limited to the area occupied by the granitic veins; though, of course, the mode of occurrence of the tin at Moolyella * and Cooglegong in the heart of the granite some miles from its edge points to the fact that the tin at Wodgina need not of necessity be confined to the relatively narrow strip which comprises the apophyses of the granite mass.

The granite region of this portion of the Pilbara Goldfield covers an area of, as may be seen by an inspection of the Geological Sketch Map which forms the frontispiece to this report, at least 2,400 square miles. The Wodgina belt proper extends, so far as

* Preliminary Report on the Geological Features and Mineral Resources of the Pilbara Goldfield: A. Gibb Maitland, Government Geologist. Geol. Surv. Bull. 15. Perth: By Authority: 1904, pp. 102-109.

observations have at present been carried, for a distance of at least 80 miles north-west and south-east, and has a width of about 30 miles.

The granite is composed of quartz, felspar, and mica, which latter is chiefly muscovite. The exact age of the granite cannot as yet be determined; it passes under the Nullagine Beds which are assumed to be of Cambrian Age, hence, such being the case, the granite must be at least pre-Cambrian.

When laid down upon a map and viewed broadly, it is noticed that these veins have a rude parallelism, generally north-east and south-west, which is coincident with that of the dominant structural features of the district. The exception is in the case of those veins which traverse the greenstones; here, where the dykes have been mapped, their general strike is north and south. In those cases in which the dykes depart markedly from what may be called the normal strike of the schists, it may be that the veins have followed old pre-existing fracture lines.

These pegmatite veins are seen to be offshoots from the main granite mass which covers such a large area of country to the east; a triangular portion of this granite occupies the south-eastern corner of the area mapped, and from this mass veins are seen to emanate. An interpretation of the general relationships of these veins to the main granite mass is shown in the geological section at the foot of the map which forms Plate V.

The dykes are very irregular, both in width and underlie, and some are more persistent in strike than others; they vary from mere threads to veins over 500 feet in width, whilst their underlie has neither any prevailing angle nor direction.

These veins are made up of a coarse-grained rock composed of mica, quartz, felspar, and occasionally tourmaline, and may be described as pegmatite, using the term in the sense in which it was applied by Delesse for any coarse-grained granitic rock containing mica, quartz, felspar and tourmaline.

In the vicinity of and along the margins of many of the pegmatite dykes are bands or bunches of tourmaline; in some cases these tourmaline bands occur only on one side of the dykes, constituting as it were a marginal zone either in the dyke or in the adjacent country rock. In others the pegmatite dykes consist almost entirely of quartz, and are crowded with tourmaline, sometimes to such an extent as to make up fully one-third of the entire rock [6450].

The tin ore appears to be an original constituent of the veins; it is, however, so far as observations have at present been carried, concentrated along certain lines in these dykes, and does not appear to be generally disseminated in minute quantities in the pegmatite. The tin occurs in all shapes, from minute grains up to pieces weighing as much as 50 or 60 pounds.

The bed of the ravines and the slopes on the hill sides carry detrital and residual tin and tantalite everywhere over the whole

area occupied by the pegmatite veins; and in many cases the detrital and residual tin has been traced to the pegmatite veins.

These pegmatites vary very much in their characters, even in different portions of the same vein.

The pegmatite [6478] which forms the tin lode of the Stannum mine, M.L. 79, is a coarse-grained rock, which traverses the whole length of the property, and sends off three branches indicated on the Geological Sketch Map of the Stannum Group, Plate VI. The rock is made up of quartz, albite, an amethystine lithia mica, blue semi-transparent tourmaline, together with clear colourless topaz, which latter exhibits well-defined cleavage.

The very coarse-grained pegmatite [6466] opened out in J. C. Williams' (or Bull's) lode claim, consists of quartz, a coarsely crystallised grey felspar, orthoclase, together with about equal proportions of a fine-grained white felspar, which proved on investigation to be albite. A partial analysis of the orthoclase in the survey laboratory showed it to contain 12·80 per cent. of potash (K_2O) and of soda (Na_2O) 3·00 per cent.

The bluish-coloured pegmatite [6454] which forms the lode traversing the Tinstone mine, M.L. 89, is a medium-grained rock, consisting principally of quartz, lepidolite, together with orthoclase. The rock owes its colour to the presence of the mica, lepidolite.

Apart from the granite, which occupies the south-eastern corner of that portion of Wodinga which has been geologically mapped, the country is occupied by a belt of schistose rocks, some of which may have affinities with those of igneous origin [6461], together with a large development of grits, quartzites, etc., which dip at varying angles to the westward.

Above these lie a great thickness of laminated iron-bearing quartzites [6460], together with some very siliceous quartzites, with scarcely any iron [6452]. Portions of the ferruginous quartzites are very much puckered and contorted, and even in hand specimens [6460] exhibit faulting on a very minute scale. These beds, which are associated with bands of a nondescript rock approaching very closely to very ferruginous and siliceous clay slates, have on lithological grounds been separately distinguished on the Geological Sketch Map of the field, Plate V. The relation which these highly-ferruginous beds bear to those of the lower western slopes of the range is by no means clear, though there are very strong grounds for the belief that in some portions of the field the junction between the two series is marked by a line of fault.

At a point (A) on the map is a fairly conspicuous band of a quartz rock, which looks like a dyke; this continues without interruption to the north angle of M.L. 88, where it has been faulted. The same rock extends also for about 10 chains north-east from (A); on account of its making such a conspicuous feature in this portion of the field, it has been separately distinguished on the geological map.

The north-eastern portion of Wodgina is occupied by fine-grained bedded greenstone [6453], which in some places is vesicular and in others occasionally agglomeratic. The pegmatite veins which carry the tantalite occur in this greenstone area.

The general relationship of these rocks to one another is shown in the section at the foot of the geological map, Plate V.

A very short distance east of the Government Well No. 1, and just outside the eastern boundary of the geological map, is about 15 or 20 feet of a conglomerate of subangular quartz, which rests directly upon granite. The conglomerate is of much more recent origin than the sedimentary rocks of Wodgina. Fragments of this newer conglomerate strew the surface over a considerable area, showing that the formation must have been more extensive than at present obtains. It is possible that this conglomerate is an outlier of the Nullagine Series, which occurs in great force in other portions of the district.

The Ore Deposits.

The following are full particulars regarding any of the workings, on the various ore deposits, opened up at the date of my visit to the field. For purposes of convenience, the deposits are described under the names of the respective leases.

M.L. 88, Nielson.—This property is the most southerly of all the leases situated at Wodgina proper. It lies about a mile south-west of the Government Well, sunk on the east side of the range of hills which separates the two mining camps.

The tin lode on this ground was discovered by tracing the tin found in the creek below up the side of the hill to the site of the present workings.

By far the larger portion of the property is included within what may be called the tableland, at a considerable elevation above the general level of the surrounding country. The ground is occupied by quartzites, mica, and hornblende slates, in addition to the iron-bearing quartzites (?), which latter cover fully three-quarters of the surface.

The only workings on the ground are situated near the northern boundary, and high up on the eastern face of the range. Operations have been confined to a thin sigmoid-shaped pegmatite dyke, which is traversed by two, apparently vertical, faults having a general strike of north-east and south-west.

The westernmost working is an opencut, exposing a total thickness of eight feet of rock, containing a band of quartz (pegmatitic) three feet in thickness, associated with from 12 to 18 inches of a yellow clayey rock, which in all probability represents the aluminous portion of the pegmatite. This rock (the lode) has been faulted against the iron-bearing quartzite (?) on the west. So far as can be seen in the present condition of the workings, the quartz vein appears to underlie southwards at a very low angle.

The band upon which prospecting operations were being carried out can be followed round the face of the hill to the eastern work-

ings, which are 142 feet distant. At one spot between the two workings the quartz vein has increased in thickness to 10 feet, but diminishes rapidly to the east. In the eastern workings, the decomposed clayey rock (pegmatite) is about five feet in thickness and exposes coarse angular tin [6451]. A very good pocket of ore is said to have been obtained from these workings, and, from what was pointed out to me, it appears that the rich ore pockets seem almost invariably to have occurred near those spots where the lode is intersected by the faults.

From the eastern workings the dyke (the "lode") can be followed for some distance round the hill in the direction of and to the point shown upon the plan, Plate V. The dyke intersects a vein of quartz, which can be followed across country for a considerable distance to the north-east; this is of some importance, in that it shows that prior to the formation of the tin-bearing veins other reefs had not only been formed but faulted.

M.L. 89, Tinstone, Hazelwood.—The ground embraced within the boundaries of this lease lies near to and adjoins the south-west angle of the Cassiterite, M.L. 84.

The property lies in the heart of the main range, and is drained by the two important tributaries of the Two-mile Creek, the headwaters of the northern branch, a steep-sided ravine having been worked in a more or less desultory fashion for the detrital tin it contains. The surface of the lease is occupied by the iron-bearing quartzites (?) which everywhere make up the staple formation of range. These bedded rocks are intersected by six distinct pegmatite veins, the positions of which have been laid down with a considerable degree of accuracy upon the geological map. In three cases the underlie of the veins could be distinctly made out, and in two of them the amount accurately measured; these data have also been indicated on the map.

In the north and south pegmatite vein which enters the lease from the eastern boundary of M.L. 85, the Commonwealth, is a quartz [6454] of a cobalt blue colour, containing what appears to be small crystals of felspar.

The most southerly working on the property is an open cut near the western extremity of the kylie (boomerang) shaped pegmatite, which underlies at 35 degress to the northward. This open cut exposes a thin vein of tourmaline rock [6454] underlying at the surface at an angle of 35 degrees to the north, 40 degrees west, though at the bottom the vein dips at a slightly steeper angle, 45 degrees, but in the same direction. This vein is of a dull leaden grey colour, and contains tourmaline and mica in much smaller quantity, together with a little tin. It forms the footwall of a decomposed pegmatite vein of about two feet in thickness, and rests directly upon quartzite of the prevailing type. This dyke can be followed round the slope of the hill to a point almost directly above the mouth of the main tunnel.

This tunnel has been driven for a distance of 64 feet in a general direction of south 30 degrees west along the feather edge

of a pegmatite dyke, which, near the mouth, is 2 feet 6 inches in width and with a high underlay to the east. Sections in the tunnel show the dyke to be faulted, and in all probability it is separated from that last described by a fault, as shown in the Fig. 5. Both walls of the dyke are highly micaceous and contain tourmaline; whilst the felspars of the pegmatite are very rapidly decomposing in the direction of kaolin. A few feet further west is an open cut along the outcrop of the vein worked in the tunnel; it contains coarse angular tin and tourmaline.

Fig. 5 shows the relation of the different veins to one another.

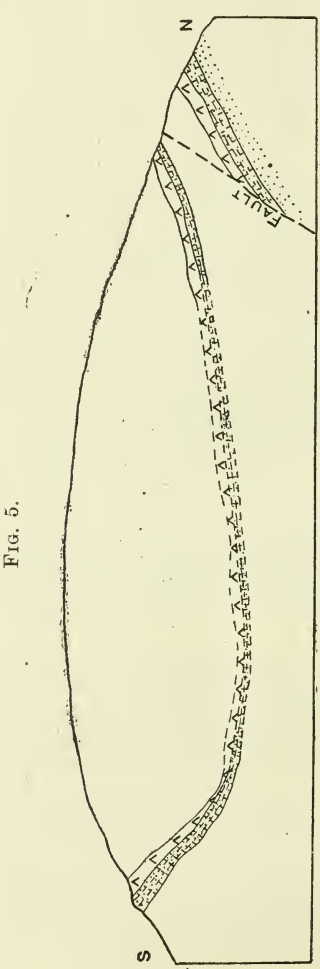


Fig. 5.

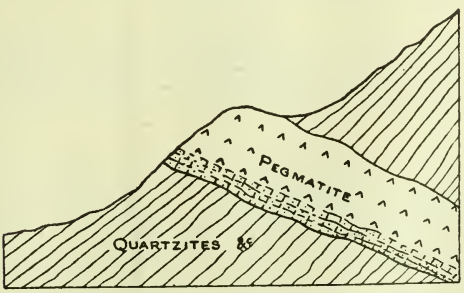
M.L. 91, Wodgina Star.—This property adjoins the Cassiterite lease on its north-east corner, and on the eastern slopes of

the high ground which forms the main axis of the tinfield. The surface is drained by the upper portions of three creeks which fall into the tributaries of the Turner River. The northermost creek has been more or less extensively worked along its whole course. A large portion of the surface is occupied by pegmatitic veins, the position and extent of which are indicated upon the Geological Sketch Map, Plate V.

The only work other than that in the creek done upon the ground is the sinking of a shallow prospecting shaft near the head of the northern creek, close to the boundary of the Cassiterite lease. This shaft had, at the date of my visit, been carried down to a vertical depth of 20 feet, through the normal country rock of the field, which in the shaft was found to be dipping at an angle of 60 degrees to the north-east. The shaft, as may be seen by an inspection of the map, is just upon the north side of a thin pegmatite vein, which extends from the adjoining lease on the west. The detrital tin in the gully below the shaft in all probability owes its origin to the disintegration of the dyke previously mentioned, and possibly in part to the one more immediately adjoining it on the north. No other work has been done upon the lease beyond that described.

M.L. 85, Commonwealth.—This lease adjoins the Cassiterite on the south. The larger portion of the surface is occupied with the quartzites, and a small triangular patch of greenstone occupies

Fig. 6.



SECTION ON THE COMMONWEALTH LEASE M.L.85
WODGINA, PILBARA GOLDFIELD.

the north-west angle of the lease. The quartzites, etc., are traversed by granitic and pegmatitic veins, the relative positions of which are indicated on the Geological Sketch Map. The only work done on this lease consists of an open cut 25 feet long, put in along the face of a pegmatite dyke, six feet thick, which underlies at a low angle to the west. The under surface of the dyke, Fig. 6

contains a foot or two of a micaceous and tourmaline rock [6464] carrying tin of the ordinary type. Many large crystals of tin may be seen in the rock.

M.L. 84, Cassiterite.—This lease is the largest and earliest of any of the holdings at Wodgina. The ground was originally taken up by Messrs. A. G. McCarthy and David Ogilvie, in the year 1903, since which date it has, according to the official figures, produced 12·35 tons of tin.

The property occupies the highest portion of the range, which forms the backbone of Wodgina, and is drained by the tributaries of McCarthy's Creek, from one of which, Ogilvie's Gully, a considerable quantity of detrital tin has been obtained. Considerably more than two-thirds of the surface of the Cassiterite is occupied by flaggy quartzites and ferruginous clay slates of the type common to the district. The south-western portion of the lease is occupied by greenstones, which make up the whole of the country to the west.

An important feature in the geology of the property is the number and extent of the pegmatite veins which intersect the country rock in all directions and cover a fairly extensive area of the surface. The section which accompanies the geological map shows the relation which these dykes bear to one another.

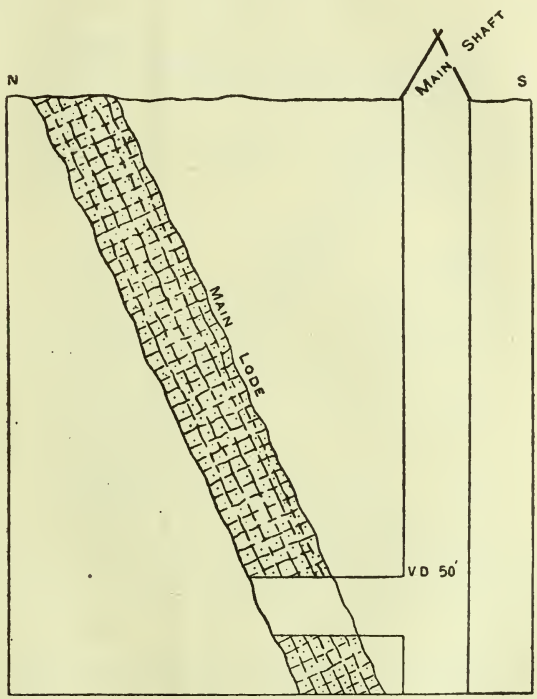
Not very much work has been done upon the lease considering the time it has been in existence.

Operations have up to the present been principally confined to what is known on the main lode, which is situated on the highest portion of the ground near the north-west angle of the lease.

The main lode extends for some distance across the surface in a north-east and south-west direction. It outcrops north-east from the northern boundary of the lease for a distance of about 100 feet, at which point it ceases to make any appearance on the surface. On the northern boundary of the lease, and just outside it, is an inaccessible vertical shaft (1) sunk to a depth of 20 feet, apparently upon the main lode; at the mouth of the shaft is a quartz reef (? pegmatite) 18 inches in thickness. The main lode, which contains coarse angular tin [6463] can be followed from the creek which crosses the northern boundary of the lease up the side of the hill in the direction of the main shaft. At 80 feet up from the creek the main lode has been opened up to a depth of 11 feet; at the surface it is four inches in width but has increased to two feet, eight inches at the bottom. Very coarse angular tin occurs in the lode along the outcrop. One hundred and twenty feet further to

the south-west is the main shaft. At the date the property was visited, the shaft had been carried down to a vertical depth of 50 feet, at a point about 30 feet south from the outcrop of the lode. At the foot of the shaft, which had been carried down through country rock, a crosscut had been put in to the north for a distance of about eight feet, at which point the lode was met with, Fig. 7.

Fig. 7.



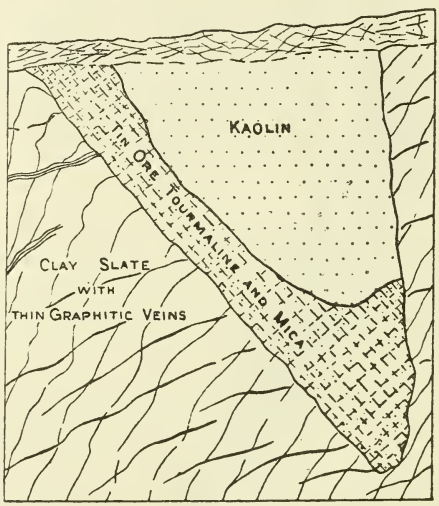
SECTION AT THE MAIN SHAFT, CASSITERITE LEASE
M.L. 84 WODGINA, PILBARA GOLDFIELD.

The lode, which proved to be very micaceous, had been stripped and showed slickensided faces. Coarse grey angular tin was showing on both walls of the lode, which was about eight to nine feet thick. No other work than this appeared to have been done upon the lode. From what was to be seen along the outcrop and in the crosscut at 50 feet below the surface, the impression left

upon the mind was that the lode occurred along a line of fault of which several occur in the district.

At a point about 500 feet southward from the main shaft is an opencut, nine feet six inches wide, 10 feet deep and about 22 feet in length, put in high up on the face of the range. This excavation shows a wedge-shaped vein, six or seven feet in length, a section of which appears in Fig. 8.

Fig. 8.



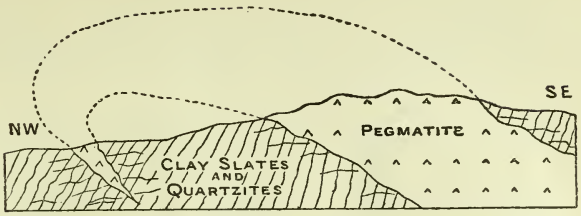
SECTION ON THE CASSITERITE LEASE M.L.84
WODGINA, PILBARA GOLDFIELD.

The lode occurs in a somewhat ferruginous clayey slate or quartzite, intersected by numerous graphite veins. The slates contain relatively large quantities of a green mineral [6467] pinguite, a variety of chloropal. This green clayey-like mineral, when examined in the laboratory was found, at the hands of Mr. Simpson, to consist of Fe_2O_3, $Si\ O_2$ (32·2 °/$_o$) and H_2O (20·1 °/$_o$), together with traces of alumina and magnesia. The lode consists principally of tourmaline and mica, together with tin ore, and is associated with kaolin, which in all probability represents the decomposition product of a pegmatite vein.

What may be called the main pegmatite vein of the Cassiterite Lease lies at a point about 40 feet south from this, and it is possible that the vein, exposed in the open cut, prob-

ably formed part thereof; the relationship of the two being shown in Fig. 9.

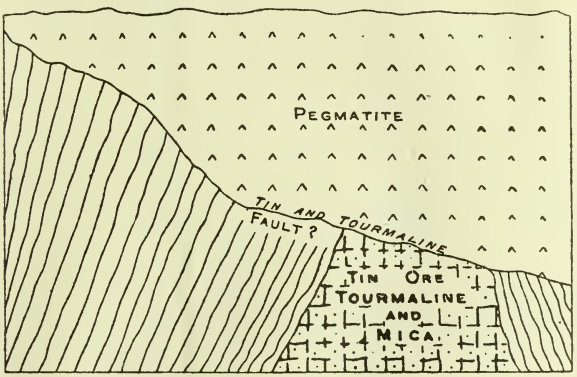
Fig. 9.



SECTION SHEWING THE POSSIBLE RELATION OF THE VEIN IN FIG. CASSITERITE LEASE M.L.84. WODGINA, PILBARA GOLDFIELD.

Another open cut, about 13 feet deep, has been put in at a point on the slope of the hill overlooking McCarthy's Creek, distant about 200 feet to the north-west of the main shaft. This open cut shows the following section:—

Fig. 10.



SECTION IN OPEN CUT ON CASSITERITE LEASE M.L. 84 WODGINA, PILBARA GOLDFIELD

The pegmatite dyke which forms the upper portion of the open cut is about seven feet thick, where exposed. It rests upon country rock of the usual type, the junction between the two being possibly a line of fault. The footwall of the vein contains a little tin and tourmaline. In the deepest portion of the open cut there is an irregular mass of mica, tourmaline, and tin, about four feet thick on its upper surface. It had not, however, been followed to any depth, so its behaviour underground could not be ascertained.

The only other work of any importance done upon the lease is that near the south-west angle, not far from the junction of the greenstones.

At this point, the position of which is indicated upon the Geological Sketch Map, is a vertical shaft, No. 2, which had been carried down to a depth of about 22 feet. A granitic (or pegmatitic) rock was met with at 16 feet from the surface, and at the date of my visit it occupied the whole depth of the shaft. A drive had been put in at 16 feet for a distance of 15 or 16 feet, in a general direction of north 45 degrees east. About 30 feet northward from

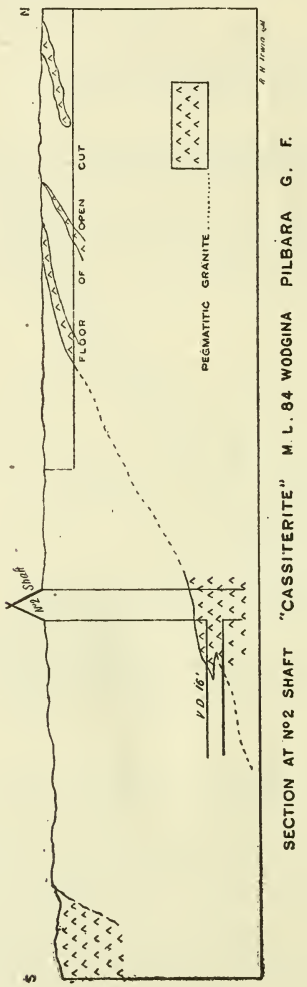


Fig. 11.

the mouth of the shaft is the outcrop of one of the large granitic (or pegmatitic) veins, which traverses a considerable portion of the width of the lease. The relation of this vein to that encountered in the main shaft is not by any means clear. (Fig. 11.)

An open cut, 25 feet west from the shaft shows, as has been indicated in the figure, several similar thin veins, which in all probability mark the terminal points of offshoots from the main system of dykes. The open cut is 63 feet in length; about 14 feet from the northern end of it is a thin vein, separated by about 16 feet from another, which measures about 12 inches in thickness, but gradually thins out to the surface of the ground. A somewhat thicker vein of about 24 inches makes its appearance at a distance of about 16 feet south from the last mentioned. There seem very good geological reasons for the belief that this vein connects with that met with in No. 2 shaft. Fairly coarse angular tin has been met with at several places in the open cut, and in all probability it owed its origin to one or other of the veins exposed therein.

A fair quantity of stream tin has been obtained by dryblowing that portion of Ogilvie's Gully which traverses the lease. One specimen [6271] from this gully presented by the owners, and now in the Museum of the Geological Survey, weighs 43lbs.; whilst another fragment (about one-half) of a large crystal [6272] from the same lease, and now on exhibition in the Geological Museum, weighs 28lbs.

The following table shows the production of tin from this lease so far as can be obtained from official sources :—

Table of the Tin Yield of the Cassiterite Lease, M.L. 84.

Year.	Tin ore raised.	Value thereof.
	tons.	£
1904	6·35	497
1905	7·50	635
Total	13·85	1,132

M.L. 110, Messrs. Gummow, May, and Dawson.—A lease, which has been applied for, adjoining the north-west corner of M.L. 84, overlooking the West Wodgina townsite, has been the scene of a little prospecting.

A vertical shaft (inaccessible to me) had been put down to a depth of 22 feet through quartzite; the shaft lies some little distance to the west of the small creek flowing northwards, which has been more or less extensively worked for the detrital tin it contains. A few feet west of the shaft a micaceous pegmatite vein has been opened up in one or two places, but no work of any moment has been done upon it. Coarse angular tin was showing in some of the micaceous rock lying near the mouth of the shaft. A bold quartz reef outcrops on the north side of the creek and to the east of the shaft previously alluded to.

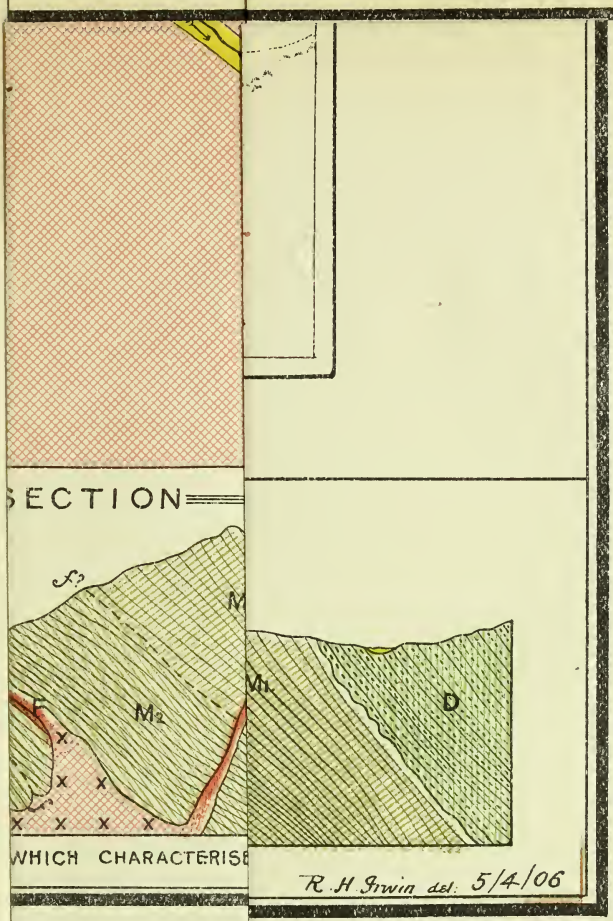
M.L. 94, Hazlewood.—On the ground pegged out as a lease, adjoining the northern boundary of M.Ls. 91 and 84, a little work

has been done upon a vein of pegmatite which outcrops near the summit of the hill, upon the northern slopes of which one of the tributaries of McCarthy's Creek takes its rise. The creek flows generally north-east and falls into the main watercourse a short distance west of the tantalite lode. The upper portion of this creek, which flows in a constricted rock-bound channel, has been more or less extensively worked, but there appears to be no record of the actual quantity of detrital tin obtained from it.

At a point (X) upon the map, a tunnel 47 feet in length has been driven into the face of the hill upon a well-defined lode underlying at a high angle to the north. The footwall of the lode is a line of fault, marked by numerous slickensided faces, which underlies to the north. The lode is very micaceous and in places kaolinic; the highly micaceous portions [6465] contain tin of the usual type. The exact thickness of the lode does not appear to have been ascertained, it is at least three feet thick. The lode can be followed south-westward to the boundary of the Cassiterite Lease, beyond which there appears to be no sign of it; it is possible, however, that the vein may be coterminous with one of those which form the main system of the Cassiterite Lease. The tin obtained from the creek was in all probability derived from the disintergration of this lode.

M.L. 117, McCarthy (formerly J. C. Williams' or Bull's Claim).—A claim, held by J. C. Williams, has been worked on the north-western boundary of the Cassiterite Lease: the position of the claim, owing to the ground not having been surveyed, cannot be indicated upon the Geological Sketch Map, Plate V., of the field. Its position may be approximately located by the shaft upon it, which is situated at a point on the western boundary of the Cassiterite Lease, distant about 500 feet from its north-west angle. An open cut, 45 feet in length, has been put in along the northern edge of the dyke, which is about 40 or 50 feet wide. The dyke, itself, consists of a rock [6467] made up of quartz, a coarsely crystallised, grey, felspar orthoclase, together with about equal proportions of a fine-grained white felspar, which proved, on examination, to be albite. Good, coarse, angular tin occurs along either wall of the dyke, and was showing in the dyke itself. It is stated, upon authority, which may be considered reliable, that about four or five tons of tin ore had been raised from this spot alone. A shaft was being sunk on the southern wall of the dyke, and at the date of my visit it had been carried down to a depth of about eight feet, and very good prospects of tin were obtained from the surface, near its mouth. So far as could be judged from what was available for inspection, the northern wall of the dyke appeared to dip to the south at an angle of about 50 degrees, whilst the southern wall seemed to be going down almost vertically. This vein is one of those which passes into the Cassiterite Lease, and adjoins the main shaft on the top of the hill.

General.—Several other claims have been worked on the field for the residual tin, but they merit no special description.



overnment Lithographer. Perth. W A

THE HON: H. GREGORY M.L.A.
Minister for Mines.

GEOLOGICAL SKETCH MAP

OF

WODGINA TINFIELD

PILBARA G. F.

BY

A. GIBB MAITLAND.
GOVERNMENT GEOLOGIST.
and
H. W. B. TALBOT.
FIELD ASSISTANT

1905

0 10 20 30 40

SCALE OF CHAINS

EXPLANATION OF COLOURS & SIGNS

ALLUVIAL DEPOSITS ..... ~

SLATES, SCHISTS &c M2

IRON-BEARING QUARTZITES M1

GREENSTONES (Lavas, Ashes &c) ..... D

GRANITE ..... Gn

PEGMATITIC GRANITE VEINS (Tin bearing in places) ..... F

QUARTZ ..... Q

FAULTS ..... f

DIP AND STRIKE OF STRATA ..... 30°

GEOLOGICAL BOUNDARIES { Where certain ..... / doubtful ..... }

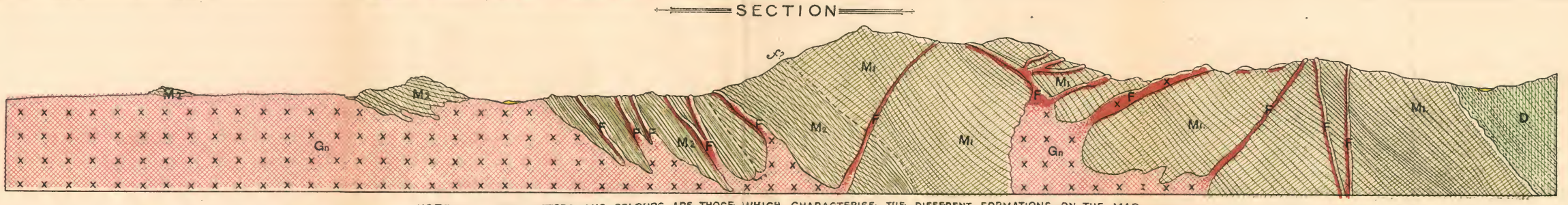
EXISTING SURVEYED LEASES { Name of ..... CASSITERITE / Nº of ..... M.L.86 / Boundaries of ..... }

LEASES APPROVED BUT NOT SURVEYED & POSITION SUBJECT TO ALTERATION M.L.101

TIN WORKINGS .....

Locality Plan

SECTION



NOTE — THE LETTERS AND COLOURS ARE THOSE WHICH CHARACTERISE THE DIFFERENT FORMATIONS ON THE MAP.

R.H Irwin del. 5/4/06

H.J Pether, Government Lithographer. Perth. W.A

In addition to the leases, etc., described above, by far the greater portion of the tin so far obtained from Wodgina and Stannum has been derived from the stream and residual deposits. The quantity derived from this source is shown in a tabular form below:—

Table of the Tin Yield of Sundry Claims of Wodgina.

Year.	Tin ore raised.	Value thereof.
	tons.	£
1905	12·50	1,030
Total	12·50	1,030

The Stannum Group.

(*With a Geological Sketch Map, Plate VI.*)

A group of three tin leases is situated about eight miles south-west from Wodgina proper, in the heart of the range, which extends from the latter locality. Upon these leases are several tin-bearing pegmatitic dykes, which have been more or less exploited, and according to the official figures have produced, up to the end of 1905, 6·20 tons of tin of an estimated value of £365.

A geological survey of the more immediate vicinity of the leases was made, and the results of which are shown on Plate VI. The leases on this map are shown in their relative positions. In its general geological features the country differs in no essential particular from the main mining centre of Wodgina. Granite occupies both sides of the main range, and sends out into the schists, etc., granitic and pegmatitic veins which everywhere form the matrix of the tin ore.

In the vicinity of the Stannum, and occupying a portion of the lease, M.L. 77, is a very large area of intrusive porphyry [**6474, 6475, 6476, 6480**] which is of later date than the greenstones, etc., which it pierces, and older than the granite and pegmatite veins. The mutual relationship of the two series is shown on the Geological Map of the group, Plate VI.

From the main mass of the porphyry, which occurs on the Stannum Lease, M.L. 77, and forms the junction of the greenstones and the iron-bearing quartzites, three dykes emanate and are indicated on the map. There are, however, several others which lie outside the area mapped.

This older porphyry varies very much in its general characteristics in different portions of its mass. One variety [**6480**] is a somewhat fine-grained, flinty-looking rock, which, under the micro-

scope, is seen to consist of plagioclastic felspar, with the characteristic turbid mealy aspect, a little dichroic mica, set in a fine quartzose mosaic.

M.L. 77, STANNUM.—The Stannum Lease, which appears to have been the scene of the first discovery of tin in this portion of the district is drained by two important creeks, the relative positions of which is shown upon the Geological Sketch Map, Plate VI. The lease is made up of apparently bedded (? cleaved) greenstone, intersected by a mass of porphyry, which seems to have been subjected to the same set of stresses and strains which affected the greenstone which it pierces. These rocks are traversed by a very persistent dyke of pegmatitic granite which traverses the whole length of the lease, after crossing the southern boundary of the property it extends southwards for about 500 feet and far beyond the limits of the area mapped. So far as this dyke, which is but thin, has been traced, it has a length of at least 3,500 feet.

Near the centre of the property two branches of the vein extend for short distances to the east. The northernmost branch has been followed down on the dip for a distance of from 15 to 20 feet, at an angle of 35 degrees; the dyke averages about two feet in thickness. This vein sweeps round the face of the hill to a point about 15 feet from the main shaft, in which it is stated to have been met with at about 18 feet from the surface. The shaft, however, was inaccessible at the date of my visit.

The southernmost branch vein has been opened up to about five feet along the dip, which at this point is about 20 degrees to the south; the vein is about 12 inches in thickness and shows tin in the faces. At a point on the main vein, distant about 200 feet west of the vertical shaft, it has been opened out for about 10 feet down the dip, which is about 15 degrees in a direction south 15 degrees west. The vein is 12 inches in thickness, and carries very coarse angular tin. Some desultory prospecting has been done at different points along the outcrop of the vein on the property, and judging from what can at present be seen on the surface, a little tin must have been found.

A little distance to the north of the main shaft is an extensive alluvial flat, which traverses the northern portion of the lease, and attains a maximum width of about 200 feet.

Upon that portion of the alluvium which lies directly north of the main shaft a fair amount of surfacing has been done and the ground stripped to three or four feet. A fairly large quantity of very clean subangular tin has been obtained therefrom. This tin owes its origin to the disintegration of the granite veins in its proximity. The quantity of tin from this source is probably represented by the yield of this property for 1905, shown in the table below, viz., three-quarters of a ton.

The following figures give, in a tabular form, the total tin yield of the Stannum Lease, so far as can be obtained from the official figures:—

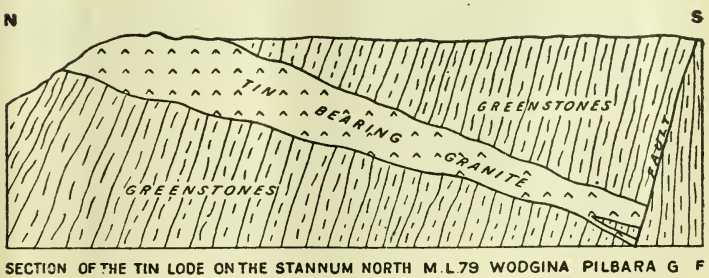
Table of the Tin Yield of the Stannum Lease, M.L. 77.

Year.	Tin ore raised.	Value thereof.
	tons.	£
1902	1·00	56
1903	·75	45
1904	2·60	139
1905	·75	60
Total	**5·00**	**300**

M.L. 79, Stannum North.—This lease lies on the lower slopes of the main range in the greenstone country, at the foot of the mass of quartzite, which occupies a large area of country in the vicinity. The lease is traversed by two tin-bearing granite veins [6477], which dip to the south at an angle of about 16 degrees. One of these has been opened out in three places. The most extensive of the two veins, "the lode," follows the contour of the hill as indicated on the map, Plate VI., and outcrops in the creek below at a point about 200 feet from the easternmost workings. It has been opened out in three places, the most westerly being a tunnel 32 feet in length driven along the vein, and dipping south at an angle averaging about 16 degrees. The vein is about four feet in thickness near the north of the tunnel, but gradually diminishes down the dip. At the face of the tunnel the vein is about 12 inches in thickness.

The section which forms Fig. 12 shows this vein.

Fig. 12.



SECTION OF THE TIN LODE ON THE STANNUM NORTH M.L.79 WODGINA PILBARA G F

M.L. 80, Comet.—The Comet Lease lies on a totally different watershed to that which includes the Stannum group. The ground is situated on the southern slopes of a very high precipitous range,

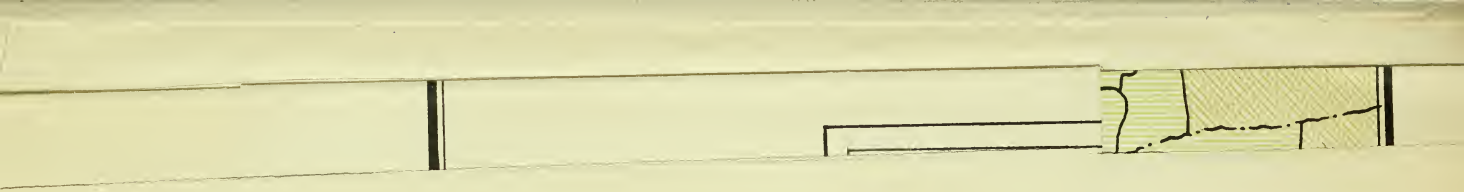
which rises to a considerable altitude above the level of the creek below. The lower portion of the leases is occupied by cleaved greenstone of the type prevailing in the district, which is traversed by several faults, the position of which is indicated on the Geological Map. The iron-bearing quartzites occupy the higher portions of the country, and make a very prominent feature in the district. As may be seen by an inspection of the geological plan of the lease, Plate VI., the central portion of it near the junction of the two formations is traversed by a small micaceous granitic vein [6471], which carries a little tin. The vein has been opened out by a tunnel driven 50 feet into the face of the hill on a bearing of north 45 degrees east at a considerable elevation above the level of the creek. The tunnel has been carried along the vein, which varies from two to three feet in thickness. At 25 feet, however, from the mouth of the tunnel its place is taken by vertical beds of quartzite identical with those forming the higher ground on the northern portion of the lease. It is possible that the point at which the vein disappears in the tunnel is a fault, of which there are several in the vicinity. Further round the face of the hill to the north-west the same vein has been opened up on the outcrop by a very shallow prospecting shaft, which, however, was inaccessible. A little tin was to be seen in the granite veins forming the dump at the mouth of the shaft.

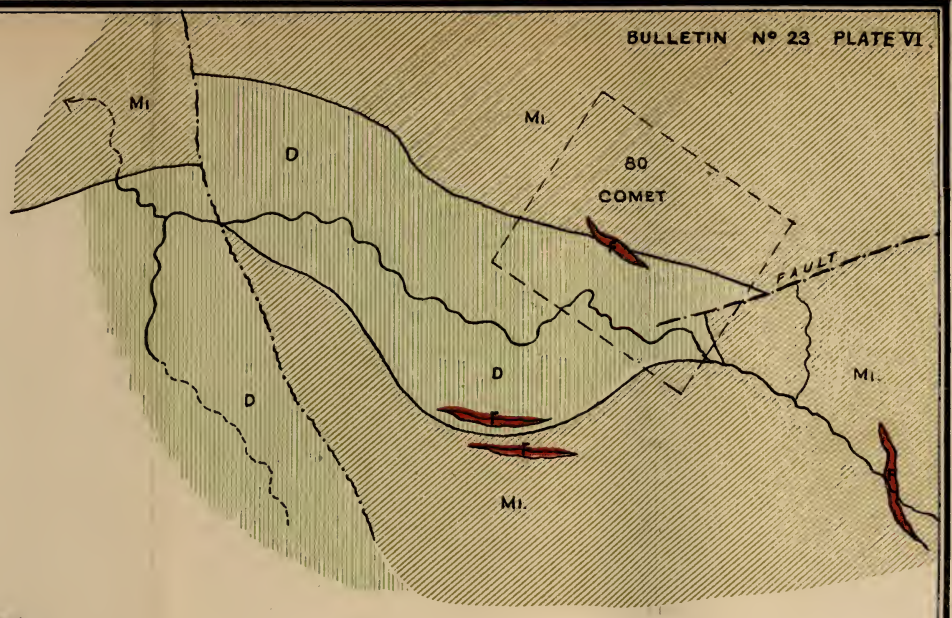
Conclusion.

Although the general result of such operations as have been carried out up to the present time indicate clearly that the existence of lode tin in sufficient quantities to be profitably mined has not been demonstrated, owing to the fact that work has hardly yet gone beyond the most rudimentary prospecting stages, there seem good grounds for the belief that the district bids fair to rise to importance, and that it will continue to be both a tin and a tantalite producer. As the tin in the deposits of the nature of those occurring at Wodgina apparently owes its origin to a separation during the cooling of molten igneous rocks, it is likely to persist to considerable depths provided the continuity of the deposits is not interfered with by faults of later date.

The development of tin lodes however is a much more lengthy process than the exploitation of residual and stream tin deposits, and of course cannot be carried out without capital judiciously expended in providing the necessary equipment and in exploration work.

The scarcity of fuel and water however is an important factor which, should the deposits on further exploration prove of commercial importance, unless successfully overcome, will act as a deterrent to profitable mining.





THE HON: H. GREGORY M.L.A.
Minister for Mines

GEOLOGICAL SKETCH MAP
OF
THE STANNUM GROUP
WODGINA. PILBARA G.F.

BY
A. GIBB MAITLAND.
GOVERNMENT GEOLOGIST
AND
H. W. B. TALBOT.
FIELD ASSISTANT.

1905

0 10 20 30 40

SCALE OF CHAINS

EXPLANATION OF COLOURS & SIGNS

ALLUVIAL DEPOSITS.....

QUARTZITES &c.....Mi

GREENSTONE.....D

PORPHYRY.....P

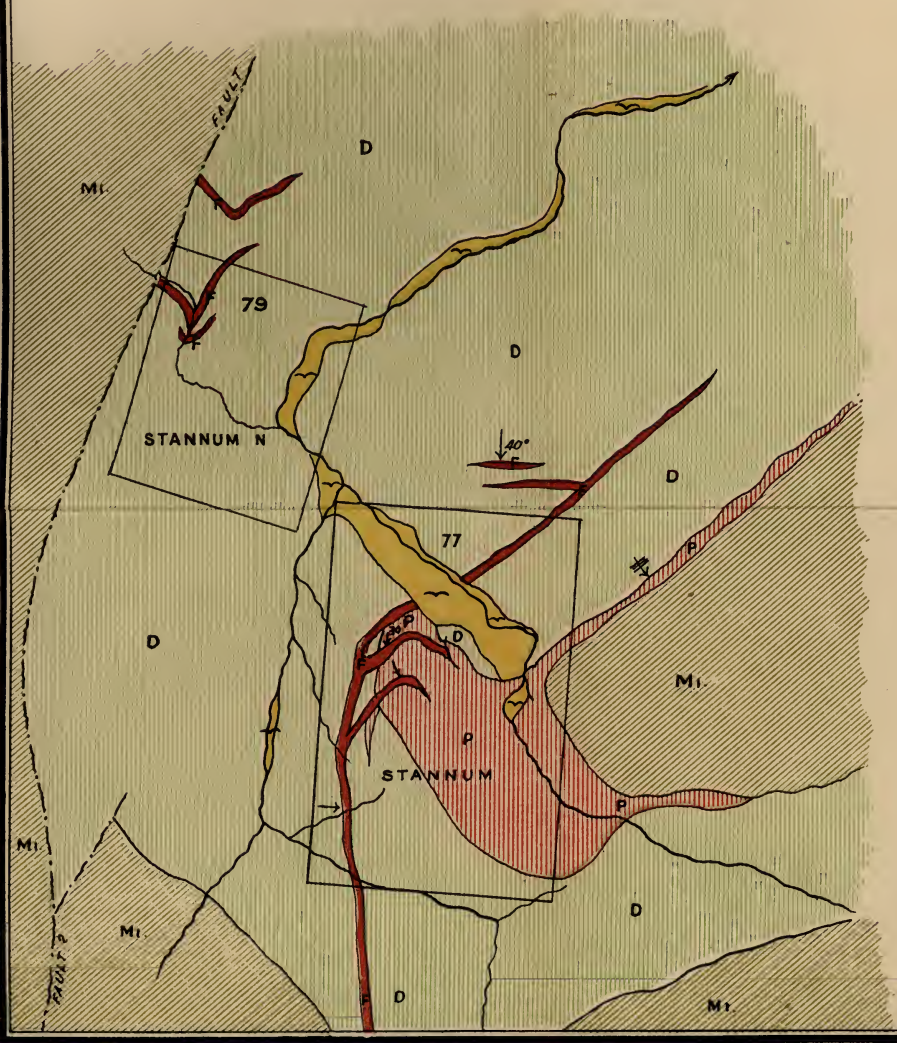
PEGMATITIC GRANITE VEINS *(Tin bearing in places.)*.....F

FAULTS.....

GEOLOGICAL BOUNDARIES

MINING LEASES. { *Name of*.....STANNUM
Number of.....77
Boundaries of.....

,, EXTINCT { .....COMET 80



Locality Plan.

Synoptical Table of the Tin Yield of Wodgina and Stannum.

Name of District.	Tin ore raised.	Value thereof.
	tons.	£
Wodgina	12·35	1,007
Stannum	5·00	300
Sundry Claims	12·50	1,030
Total	**31·45**	**2,462**

There seem very good reasons for believing that the tin yield disclosed by these figures is considerably under the truth, for the tin buyers apparently only commenced reporting their purchases to the Government towards the close of 1905.

The Tantalite Lodes. (Wodgina. Plate V.)

M.L. 86, H.M., and M.L. 87, Anchorite.—A very important feature of the Wodgina Field is what is known as the Tantalite lode, the position of which is shown on the Geological Sketch Map of the field. The "lode" traverses the whole length of two of the leases applied for, viz. H.M., M.L. 86, and Anchorite, M.L. 87. Upon the most southerly of the two not very much work has been done, operations having been confined to dryblowing the surface along the outcrop and in the vicinity of the pegmatite vein.

The pegmatite vein (the "lode") first makes its appearance outside the boundary of the Anchorite ground, to the south of McCarthy's Creek, and after traversing the whole extent of the two properties, extends northwards far beyond the limits of the geological map. The vein had been opened up in the H.M. ground M.L. 86, for a length of 45 feet, but only to a depth of three or four feet. To the north of the opencut its width is 41 feet, whilst 204 feet farther it has dwindled to 34 feet, whilst near the northern boundary a commencement had been made with the sinking of a shaft in the opencut on M.L. 86, but operations had not been carried sufficiently far to enable either the exact thickness of the vein or the amount of its underlie being obtained; as work proceeds, however, definite information upon these material points should soon be available.

The section, Fig. 13, which has been drawn to scale, indicates the relation of the tantalite lode to the surrounding rocks.

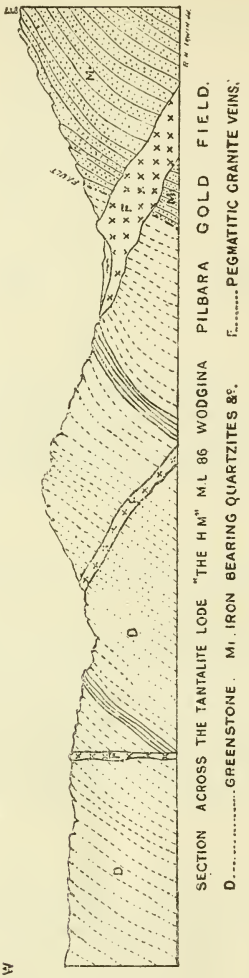


Fig. 13.

A considerable amount of dryblowing was being carried out upon the slope of the hill adjoining and to the west of the lode over the areas showing by stippling on the geological map. Several tons of tantalite, some of it being very coarse (pieces as much as 37 lbs. being not uncommon), have been obtained in this manner, and it is estimated that about 71 tons of the mineral have been taken from the surface of the leases. This detrital tantalite results from the disintegration of the rich chute occurring in the vein adjoining.

The dyke, which traverses the greenstones which make such a conspicuous feature in the geology of this portion of the Wodgina Field, though varying in its character in different portions along its outcrop, is pretty much the same throughout. It consists essentially of quartz, felspar, and in parts mica; in addition to which it contains tantalite in pieces of all sizes, the largest of which weighed about five hundredweights.

Some portions of the dyke, however, consist almost entirely of felspar [6458]; at others, quartz with minute scales of lithia mica [6457]; whilst in other places it is represented by pure quartz. In some places there seems to be a gradual passage from an ordinary pegmatitic granite to pure quartz.

About 300 feet west of the main tantalite lode is another pegmatite dyke containing tantalite; dryblowers have been at work near the southern end of it, and had obtained about one hundredweight of somewhat fine-grained ore.

What may be called the tantalite group of lodes has been followed with more or less interruption for about a mile to the north of M.L. 86, and eventually merges into the granite mass of the plains. A fair quantity of detrital tantalite has been obtained from this locality, and there is every reason to believe that the area over which the mineral occurs will be extended.

According to the returns taken from the *Government Gazette* the yield of tantalite has been, up to the close of 1905, as shown in the table below:—

Table of the Tantalite Yield of Wodgina.

Name of Lease, etc.	Ore raised.	Estimated value.
	tons.	£
H.M. and Anchorite, M.L's 86, 87	26·00	3,425
Naismith's Unreg. Claim ...	45·60	5,500
Total	**71·60**	**8,925**

Eadie's Claim.—On a bearing of 358 degrees, and distant about 78 chains from M.L. 86, is what is known as Eadie's Claim, upon which is a pegmatite dyke of the prevailing type and containing a little tantalite. The dyke measures about 20 feet in width on the surface, and occurs in greenstone country identical with, and the continuation of, that occurring in McCarthy's Creek.

The only work done, however, consisted in opening up the dyke to a depth of about three feet. This deposit is virtually the continuation of the main tantalite lode previously described, which can

be followed more or less continuously to this point, near which it disappears into the low country of the plains.

Nine hundred feet distant, on a bearing of 305 degrees, is a dryblown patch occurring on a pegmatite dyke of the ordinary type. A fair quantity of detrital tantalite had been obtained from this locality at the date of my visit.

Mount York.—A recent report from the Acting Inspector of Mines (submitted to the Minister for Mines in January last) on the occurrence of tantalite at Mount York* (Chingamong), about 20 miles east of Wodgina, in a mineral belt which trends generally north and south, and parallel to that at Wodgina, describes the only workings in the district:—

"On M.L. 100 (O. T. Bell and party) a rubbly felspar formation has been exposed for a few feet. This carries tantalite, but sufficient work has not been done to allow of an opinion as to the richness of the lode. On McBeth's alluvial reward claim (applied for) tantalite can be easily seen in the gully that traverses the claim. . . . . Several tin lodes have been pegged out in this locality, but little if any work has been done on them."

The "felspar formation" which the Inspector describes is without doubt one of the pegmatitic dykes which occur in such great force at Wodgina.

No opportunity presented itself of visiting this find, but on my way to Perth I was shown at Lalla Rookh, by Mr. Wm. Walsh, one of the owners of the find, a large quantity of dressed tantalite, a sample of which was assayed in the Survey Laboratory and yielded:—

Metallic tin	15·62	per cent.
Tantalum pentoxide, Ta_2O_5 ...	42·39	„
Niobium pentoxide, Nb_2O_5 ...	21·09	„

In this sample much of the tantalite occurred in the form of well-defined crystals.

The occurrence of tantalum ores has been known in the State for a number of years, full particulars of which have been available in several of the Bulletins of the Survey.

Tantalum was recorded as occurring in this State at Greenbushes, viz. Stibiotantalite (tantalate of antimony) in 1894.† In 1900, Tantalite (tantalate of iron) was detected in the Survey Laboratory, in some of the alluvial wash from the Greenbushes Tinfield; Manganotantalite (tantalate of manganese) in 1904, in material sent in from Wodgina; and in 1905, Manganocolumbite (niobiate and tantalate of manganese) and Calciotantalite (tantalate of iron and lime) from Wodgina and Mount York (Chingamong).

* The position of Mount York is not shown on any of the official maps, and has probably not been fixed.

† *J. J. East.* On Stibio-Tantalite, a new mineral from the Stanniferous Gravel at Greenbushes, Bunbury, Western Australia. Trans. Aust. Inst. Mining Engineers, 1904, Vol. I., pp. 139-142.

An analysis of a sample of manganotantalite [6459] from lease M.L. 86 has been made in the Survey Laboratory by Mr. E. S. Simpson :—

Ta_2O_5	68·65
Nb_2O_5	15·11
TiO_2	·40
SnO_2	·48
WO_3	Trace
H_2O (combined)	·07
FeO	1·63
MnO	14·15
NiO	Trace
CaO	Trace
MgO	·15
$(Ce.Y)_2O_3$	*Nil*
	100·64
Specific Gravity	7·03

The tantalite of Wodgina, as may be seen by a reference to the various analyses, contains a fairly large percentage of the comparatively useless niobium oxide. The recently announced discovery * of the perfection of a method for the separation of the tantalum oxide and niobium oxide is of importance, as it may eventually give a commercial value to those tantalite deposits which, owing to the high percentage of niobium, are at present practically useless.

Having due regard to the uses to which recent scientific research has proved the metal can be put, provided the tantalum-bearing minerals can be obtained in sufficient quantities, the find at Wodgina is of considerable importance, and should be the means of encouraging prospecting in other districts in which identical geological conditions prevail.

The following account of tantalum, its detection and uses, has been drawn up by the Mineralogist and Assayer, Mr. Simpson :—

Tantalum.

Its Detection and Uses.

Tantalum, and its so far valueless twin brother Niobium, which always accompanies it in nature, were discovered as long ago as 1801. It was not however till the year 1904 that tantalum was prepared in a state of great purity and its intrinsic qualities determined. Tantalum is prepared by passing a strong current of electricity through a rod of the pure oxide in a continually maintained vacuum, and also in an equally pure state by fusing potassium tantalum fluoride with metallic potassium in an evacuated electric furnace.

Thus prepared, tantalum is a hard grey metal, considerably heavier than silver but lighter than gold. It is very ductile, and can be drawn out into the thinnest wire At the same time, when hammered it becomes harder than the hardest steel, and has therefore been suggested as a substitute for the diamond in drilling. In a vacuum its melting point is

* The Mining Journal, London, 28th October, 1905.

found to be higher than that of platinum, but when heated in air it becomes oxidised—superficially only at a red heat, completely at a white heat. It is unaffected by all mineral acids except hydrofluoric.

Its present use is confined to providing filaments for incandescent electric lamps. For this purpose it is found to be extremely well suited, having a long life and using only about half the usual amount of current for the same candle power. The demand for these lamps is already so large that the patentees, Messrs. Siemens & Halske, are unable, with an output of 5,000 per day, to satisfy the demand. One kilogramme (a little over two pounds avoirdupois) of tantalum is sufficient for the production of 45,000 lamps. Its alloys with iron are found to combine great hardness and durability with ease of working, and it is probable that they will be put to some use in the near future.

Passing now to the question of the natural supplies of the metal, it may be stated at the outset that tantalum does not occur in the metallic state in nature, but only in a few rare and complex compounds of the oxides of tantalum and niobium with the oxides of other metals. The most important of these are:—

Tantalite (tantalite and niobate of iron and manganese).—This is the commonest and most important ore and comprises several varieties, distinguished by differences in crystalline form, and in the relative amounts of tantalum, niobium, iron, and manganese present. They are as follows:—

Tantalite, tantalum pentoxide	43 to 85 per cent.
Manganotantalite, tantalum pentoxide ...	43 to 85 „
Columbite, tantalum pentoxide	1 to 42 „
Manganocolumbite, tantalum pentoxide...	1 to 42 „
Skogbolite, tantalum pentoxide	43 to 85 „

Typical tantalite occurs at Greenbushes, manganotantalite at Wodgina (Pilbara G.F.). At this latter locality there also occurs a new variety characterised by the presence of a high proportion of lime (7·8 per cent.).* Specific gravity, 5·3 to 7·9 Colour, black; opaque.

Microlite (tantalate and niobate of calcium).—Tantalum pentoxide, 68 per cent. Specific gravity, 5·3 to 6·1. Colour, yellow to brown; transparent to translucent.

Stibiotantalite (tantalate and niobate of antimony).—Tantalum pentoxide, 51 per cent. Occurs at Greenbushes. Specific gravity, 6·4 to 7·4. Colour, grey, yellow, or brown; translucent or opaque.

Yttrotantalite (tantalate and niobate of yttrium, iron, etc.).—Tantalum pentoxide, 46 per cent. Specific gravity, 5·4 to 5·9. Colour, yellow, brown, black; opaque.

Fergusonite (tantalate and niobate of yttrium, erbium, etc.).—Tantalum pentoxide, 2 to 43 per cent. Specific gravity, 4·7 to 5·8. Colour, brownish black; opaque.

Samarskite (tantalate and niobate of iron, uranium, etc.).—Tantalum pentoxide, 2 to 18 per cent. Specific gravity, 5·0 to 6·0. Colour, black; opaque.

Tantalum-bearing minerals are usually found in granitic country, either in pegmatite veins or bands in the rock mass, or in surface and stream

* A rounded pebble [6286] weighing 18 grammes, and grey-black in colour, had a sp. gr. of 6·04 and the following composition:— Ta_2O_5 73·82, Nb_2O_5 6·44, SnO_2 ·72, TiO_2 ·54, FeO 8·42, MnO 1·39, CaO 7·78, MgO ·62, Ce_2O_3 *nil*—total, 99·73.

boulders and pebbles derived from them. Tin ore is sometimes associated with them, so that tin concentrates should be examined for their presence. It was in this way that they were first detected at Greenbushes.

There is no simple blowpipe or other test for the presence of tantalum. It is useful, however, to remember that minerals containing notable amounts of this metal are all extremely heavy. A considerable amount of time has been devoted by the author to the question of the detection and assay of tantalum ores, and the following methods have been evolved:—

Detection.—The suspected mineral or black sand or tin concentrate is ground to an impalpable powder in an agate mortar, and half as much as will go on a threepenny piece (say ½ gramme) is fused in a nickel crucible at a red heat with six times its weight of caustic potash. The crucible is cooled and the melt dissolved out with hot water and put in a beaker with a moderate excess of dilute hydrochloric acid, and boiled. If a creamy white opaque flocculent precipitate forms immediately, tantalum or niobium or both are present, and the material should be subjected to a complete assay as described below. Care must be taken not to confuse with this the precipitate of titanium hydrate formed under somewhat similar circumstances. If sufficient acid is present the latter will not form at all, but if only slight excess of acid is present it will form *slowly* on warming, gradually becoming heavier. It is finely granular as compared with the tantalum precipitate.

The value of tantalum ores depends principally upon the percentage of tantalum pentoxide (Ta_2O_5) in them, but is lessened in proportion to the percentage of niobium pentoxide (Nb_2O_5) associated with it. Roughly, ore is worth in London £1 per unit, the market being very unsettled owing to the demand at present being very restricted. Quotations twelve months ago (June, 1905) ranged from 3½d. per lb. for 5 per cent. ore up to 18s. per lb. for 80 per cent. ore.

The following determinations have been made on ores from this State:—

Tantalite, Greenbushes	...	Ta_2O_5 80·61 %	...	Nb_2O_5 2·50 %
do. do.	...	68·50 „	...	5·46 „
Stibiotantalite, Greenbushes	...	51·13 „	...	7·56 „
do. do.	...	50·57 „	...	12·58 „
do. do.	...	51·95 „	...	4·49 „
Manganotantalite, Wodgina	...	69·95 „	...	14·47 „
do. do.	...	72·46 „	...	6·80 „
Calciotantalite, Wodgina	...	73·82 „	...	6·44 „
Manganotantalite, Green's Well		54·76 „	...	27·24 „
Tantalite, near Lalla Rookh	...	70·34 „	...	4·92 „

The above assays are mainly those of bulk samples. Individual fragments from the Wodgina Field are very variable in specific gravity, and therefore also in assay value. The observed range is from 5·50 (= 10 per cent. Ta_2O_5) to 8·03 (= 84 per cent. Ta_2O_5).

Samples of these ores are to be seen in the Geological Survey Office, Beaufort Street.

Assay. 1. Simple rough Method for Buyers.—A close relationship exists between the specific gravity of tantalite and its varieties and the very variable percentage of tantalum pentoxide contained in them. In buying, therefore, clean tantalite free from tin ore, etc., a rough assay (to be subsequently checked by a chemical method) may be made as follows:—The specific gravity of several of the fragments of mineral is taken carefully,

and their mean calculated, or the specific gravity of a representative portion of the coarsely crushed sample is taken, and the percentage of Ta_2O_5 taken from the following table:—

Specific gravity		Ta_2O_5 %	Iron-tantalite.		Mangano-tantalite.
	5·3	...	Trace	...	2
	5·5	...	6	...	10
	5·7	...	14	...	19
	5·9	...	22	...	27
	6·1	...	30	...	36
	6·3	...	38	...	44
	6·5	...	45	...	51
	6·7	...	52	...	59
	6·9	...	59	...	66
	7·1	...	65	...	72
	7·3	...	70	...	78
	7·5	...	75	...	83
	7·7	...	79	...	—
	7·9	...	84	...	—

This is usually correct to within less than 5 per cent.

2. Chemical Method.—The method here described is not applicable to stibiotantalite, as it does not effect a separation of Sb from Ta and Nb. It must be modified somewhat when the Ta_2O_5 present is not greater than one-tenth of the Nb_2O_5.

Decomposition.—Crush ore through a 90 sieve and mix well. Put between three and four grammes of pure KHO in a 1½-inch nickel (or silver) crucible, cover and set over gauze to melt whilst ore is weighed out. Weigh out 0·5 gramme of ore, grinding it all very carefully in an agate mortar in lots of not more than ·2 gramme before putting it on the weighed watch-glass. By the time weighing is completed the KHO will be in a state of tranquil fusion. Remove burner and drop in the ore, mix well by quickly rotating, replace on gauze, cover and heat for 10 minutes. Remove lid and repeat rotation, then set crucible in a 1¾-inch hole in a sheet of one-eight inch asbestos so that not more than one-third of the crucible projects below. Cover and heat over naked bunsen for half-hour so that bottom of crucible is bright red. The melt is very liable to creep, but this is avoided by heating over asbestos support as here described. At the end of half-hour fusion is complete, and bunsen is removed. Remove cover carefully so as to avoid losing any of the liquid melt from its under surface. Set lid aside upside down to cool, and cant the crucible well to one side when cooling so that the greater part of the melt solidifies on the side, which makes subsequent solution rapid. While cooling, measure out 30 cc. 5E.HCl, and pour about 10 cc. into the bottom of a beaker of not less than 400 cc. capacity. Wash the lid off into this first with warm water, then with a little of the measured acid, rub well with a "policeman*," and finally wash again with water. Cover crucible with a watch glass and through a small gap on the side away from the melt fill the crucible two-thirds full with slightly warm water from a wash bottle. Action is somewhat violent for a few seconds. When it is tranquil, decant into the beaker, wash well with warm water, then with the remainder of the measured acid, rub well with policeman, and finally wash well with water.

Determination of Ta_2O_5 *and* Nb_2O_5.—Add to the solution, which should not now measure more than 80 or 90 c.c., 5 to 10† c.c. of 10E HCl and set on sand bath to boil. (The original solution of the melt is usually green from presence of K_2MnO_4, on acidifying with acid the colour changes to red from the formation of $KMnO_4$, MnO_2 and hydrates of Ta and Nb being precipitated at the same time. On boiling both $KMnO_4$ and MnO_2 are attacked, giving $MnCl_2$, and liberating Cl_2, whilst Ta and Nb hydrates remain insoluble

* "Policeman," a glass rod with a small cap of rubber tubing.

† The larger quantity is used when much Ti is present. 5 cc. is sufficient when only a little Ti or Mn are present.

except in traces. Boil the solution till all Cl_2 is driven off and the precipitate is no longer brown, but creamy white. Dilute to 200c.c. and boil for a further 15 minutes to ensure complete precipitation of the Nb. Filter through a 12c.m. paper, pouring supernatant liquor through first without disturbing precipitate, the filtration being thus hastened. The filtrate should be quite clear; if milky it probably contains Nb, which must be precipitated by further diluting and boiling. Wash precipitate on filter with boiling water until washings give no reaction with $AgNO_3$. Residue consists of hydrates of Ta, Nb (and W ?), with all Sb, and at times traces of Mn_3O_4 and SnO_2. Filtrate contains all Sn, Fe, Mn, Ca, Mg, Cu, Ni, and Ti as chlorides. The filter and residue are almost completely dried in a water oven, folded up and put in a covered and weighed porcelain crucible, and heated up gradually in a gas muffle or otherwise. When nearly red remove lid and heat to bright redness, till all carbon is burut off, then ignite a further 15 minutes. Cool in desiccator, and weigh as $Ta_2O_5 + Nb_2O_5$.

Separation of Ta_2O_5 and Nb_2O_5.—All Ta and Nb must first be obtained in the form of hydrates, either by fusing a fresh portion of ore as before, or by treating the weighed oxides in the same way as an ore. In the latter case the fused KHO must be cooled until solid before addition of the oxides, otherwise loss may occur.

It is convenient to use for the separation four platinum dishes, one each 2″, 2½″, 3″, 3½″.

The well-washed hydrates are washed almost completely off the filter into a 3″ platinum dish. The filter is then folded into four inside out, and put in a second (3½″) platinum dish, covered with hot water and a few drops of HF added, and the solution warmed on a sand bath for a few minutes. Pour off the solution into the dish containing the Ta and Nb, repeat the operation, and finally wash the filter at least four times by decantation with hot water. Set solution of Ta and Nb on sand bath to heat, and if solution of hydrates is not complete in a few minutes add one or two drops more HF, avoiding carefully any great excess. Weigh, roughly, 0·7 gram of dry KF (or more if moist), dissolve in hot water, and after heating both solutions nearly to boiling, add the KF slowly, with stirring, to the solution of Ta and Nb. Evaporate to 10c.c. Wash down sides of basin with a few drops of hot water and set on one side to cool slowly down to 15°C. When thoroughly cool, decant clear solution containing all Nb and part of Ta through a 7cm. filter into a small (2½″) platinum dish. Wash residual felted mass of spicular crystals of K_2TaF_7 with four small lots of cold (15°) water, adding washings to main solution. Evaporate over water bath to about 5c.c., cool slowly as before. Decant or filter off solution through a small (7cm.) filter, supported on a well-waxed glass funnel, into a 2″ dish. Wash with four small lots of cold (15°) water and examine residue for flat plates of K_2NbOF_5. If present, they must be removed by further washing. Evaporate solution to dryness at 100°, cool, add one drop HF and dissolve 0·1 gram of KF in 1c.c. of water. Then run into dish from a burette from 1 to 5 c.c. or more (usually 3c.c.) water according to proportion of Nb expected to be present, viz., about 1c.c. for every 7 per cent. Nb_2O_5. Heat rapidly for a few seconds to dissolve all residue, add the solution of KF, and make note of bulk of total solution, and set on one side to cool for one hour at 15°C or thereabouts*. Filter solution into a small platinum dish and wash residue three or four times with a few drops of water at 15° or less, making a note of the approximate bulk of the washings. Add to solution 8c.c. 10E H_2SO_4 and evaporate to fuming on a sand bath. Keep strongly fuming for at least 20 minutes in order to remove last traces of fluorine. See that no unattacked fluorides remain on the side of dish out of reach of the sulphuric acid. Cool and pour into 150c.c. water contained in a 300 or

* N.B.—Note more than 2° above or below 15°C. 1c.c. solution acidified with HF holds in solution at 15° ·00365 gms. Ta_2O_5 as K_2TaF_7 or ·03650gms. Nb_2O_5 as K_2NbOF_5 (on ·5gm. charge 0·73% Ta_2O_5 and 7·3% Nb_2O_5).

400 c.c. beaker. Wash out dish well with chilled water and a policeman. Boil solution for 20 minutes to precipitate all Nb and Ta associated with it, filter, wash well with boiling water and dry. Ignite until all filter is burnt, cover, add 1·0gm. solid ammonium carbonate, cover and reignite till constant in weight. Weigh the residue which contains all the Nb_2O_5 and part of the Ta_2O_5. The latter is allowed for on the following basis, viz., ·00365 gm. Ta_2O_5 for every 1c.c. of the solution in which the final crystallisation took place, and ·00091 Ta_2O_5 for every 1c.c. of wash water used in the final filtration.

Determination of Tin.—Warm the main solution containing the chlorides of Sn, Fe, etc., and pass H_2S to saturation. Filter off the SnS and wash well with H_2S water. Convert into SnO_2 as usual and weigh after ignition.

F.—COOGLEGONG TINFIELD.

The Coolglegong Tinfield is situated on one of the tributaries of the Shaw River, a little to the west of the White Quartz Hill shown upon the Geological Sketch Map of the Pilbara Goldfield, which forms the frontispiece of this report. The field is claimed to have been discovered in August, 1900, and since that date it has returned 760·35 tons of tin ore, valued at £52,179.

General Geological Features.

As is the case at Moolyella*, the Coolglegong Tinfield presents a marked uniformity in its geology, the whole area consisting of granite, which in some places is gneissose in structure. The granite covers a wide expanse of country; it extends over an area of some hundreds of square miles, and, as may be seen by an inspection of the Geological Sketch Map of the Pilbara Goldfield (Frontispiece), it appears to form part of the large mass which extends, with more or less interruption, from Corunna Downs to the Yule River. This area embraces the country which took in the old Shaw River Tinfield, which, so far as may be gathered from the official figures, has been responsible for 145·34 tons of tin, valued at £151,219.

As only four days were spent in the locality, there was very little opportunity of doing more than making a very cursory inspection of the more salient features of the district as a whole. The western margin of the granite is in close proximity to the White Quartz Hill, which forms the culminating point of a long and wide quartz reef, which has an average strike of 173 degrees and forms one of the most conspicuous features in the landscape, visible for many miles in nearly every direction.

The granite is principally composed of quartz, felspar, and mica, and presents a great uniformity in its composition over wide areas. As is the case elsewhere in the district, the granite is intersected in certain localities by veins of pegmatite, which have doubtless been the original source from which the stream and residual tin has been derived. All the tin hitherto obtained from

* Geol. Surv. Bulletin 15. Perth: By Authority: 1904. pp. 102, *et seq.*

the district has been derived from the alluvial deposits which have been formed in the existing valleys. So far as has at present been observed, these alluvial deposits do not attain any very great thickness, although their width must in many cases be very great.

As none of these alluvial deposits have as yet been geologically mapped, not very much can be said as to their extent, though there seem very good scientific grounds for the belief that systematic and judicious prospecting will result in the discovery of other deposits quite as rich as any of those yet opened up.

There is, in addition to the alluvial deposits, a fairly large quantity of residual tin, *i.e.*, ore derived from the wear and tear *in situ* of the tin-bearing pegmatite granites which traverse certain partions of the granite massif.

Considerable interest attaches to the district on account of the occurrence of the mineral gadolinite, a silicate of yttrium, lanthanum, beryllium and iron, associated with the stream tin. The occurrence of gadolinite in granite from Coogiegong Creek was noticed in the Annual Report of the Geological Survey for the year 1900,* and specimens [**2027, 6495**] of it are now in the collection of the department. The presence of numerous pegmatitic granite dykes throughout the district, and the known occurrence of tantalum-bearing minerals in one at Wodgina (p. 65) suggests the possibility of these being the matrix of the gadolinite. In other parts of the globe, the rarer minerals, Thorianite, Yttrialite, Fergusonite, Allanite, etc., have been found occurring in similar pegmatite dykes, and there is but little doubt that careful search throughout the North-West district would result in the discovery of some of the rarer earths of which at the present there appears to be a considerable demand.

During the course of the field work search was made for the vein in which gadolinite is stated to have occurred, but without success. One very pronounced vein, three or four feet in thickness, and upon which a little prospecting work had been done, was found to contain [**6494**] large quantities of garnets, both in the massive form and as crystals.

The only analysis yet made of this gadolinite was made by Mr. B. F. Davis, of Sydney, and is as follows:—

Silica, $Si O_2$	23·33
Iron Protoxide, FeO	10·38
Beryllium Oxide, BeO	12·28
Cerium Sesquioxide, Ce_2O_3	2·50
Lanthanum Sesquioxide, La_2O_3 ..)	18·30
Didymium Sesquioxide, Di_2O_3 ...)	
Yttrium Sesquioxide, Y_2O_3	33·40
Magnesia, Mg O	·69
Ignition Loss, He,H,N,CO_2	·32
	101·20

Specific gravity ... ... 4·14

* Ann. Prog. Rep. Geol. Surv. 1900. Perth: By Authority: 1901, p. 32.

Table showing the Tin Yield of Cooglegong.

Year.	Tin ore raised.	Value thereof.
	tons.	£
1900	65·06	3,687
1901	174·43	8,880
1902	91·80	6,373
1903	173·59	12,541
1904	114·34	8,664
1905	141·13	12,034
Total	**760·35**	**52·179**

The following table shows the yield of the Old Shaw Tinfield, so far as can be gathered from official figures:—

Table showing the Tin Yield of Old Shaw.

Year.	Tin Ore raised.	Value thereof.
	tons.	£
1893	* 56·45	3,470
1894	* 19·00	949
1895	*Nil*	...
1896	*Nil*	...
1897	*Nil*	...
1898	*Nil*	...
†1899	*Nil*	...
1900	4·00	300
1901	7·35	357
1902	19·00	1,267
1903	14·02	981
1904	80·57	6,107
1905	17·65	1,394
Total	**218·04**	**14,825**

* Customs records. † Prior to 1900 the Mines Department records show only 2·75 tons, valued at £124.

PART III.—General Summary.

The efforts which had been made by private enterprise towards the development of mining in the Pilbara Goldfield seemed to warrant such assistance and guidance as might be afforded by a reasonably accurate delineation of those salient geological features which had any bearing upon economic questions.

During the three field seasons spent in the district, visits were paid to, and such a detailed examination as the circumstances seemed to warrant made of, all the centres where mining was being, or had been, carried out. The three reports* may, therefore, be regarded as the results of an attempt at a systematic and reasonably detailed examination of the broader geological features of the Pilbara Goldfield, in so far as they have any bearing upon economic questions.

Whilst by far the larger portion of the reports is the direct result of my own personal observations, the manuscript reports of the Inspectors of Mines have been laid under contribution when considered necessary. The knowledge thus gained is graphically summed up on the General Geological Sketch Map, which forms the frontispiece to this report.

The district affords better and more continuous sections than are generally to be met with on any of the goldfields of the State which have yet been examined; they thus reveal geological structures which are not to be found in the more southerly districts, and, on this account, serve to throw light on many obscure points in connection with the geology of other fields.

General Geology.

The following is the geological record arranged in the form of a table, as furnished by the Pilbara Goldfield:—

Recent.—	Blown Sand. Alluvium of the River Beds. Residual Deposits.
Oakover Beds.—(Age?)	Sandstones, Limestones, etc.
Nullagine Beds.—(Age?)	Sandstones, grits, conglomerates and volcanic rocks. (*Gold bearing in places.*)
Mosquito Creek Beds.—(Age?)	Grits, shales, and fine conglomerates. (*Gold bearing in places.*)
Warrawoona Beds.—(Archæan?)	Metamorphic sedimentary rocks, quartzites, conglomerates, greenstone schists, and allied rocks. (*Gold bearing.*)
Granite and Gneiss.—	(*Tin and Tantalite bearing and Auriferous in places.*)
Dolerite, Diabase, and Gabbro Dykes.	

The Oakover Beds have only been noticed, up to the present, in the country in the vicinity of the Oakover River, below Carawine

*Geol. Surv. Bulletins, Nos. 15, 20, and 23.

Pool. The beds consist of a series of sandstones, limestones, and cherts, which have yielded no fossils, and which are not very thick. These beds rest with a violent unconformability upon an older series of limestones and volcanic rocks. There is no evidence as to their geological age.

The Nullagine Beds are largely developed in the Pilbara Goldfield, and consist of a great thickness of sandstones, grits, conglomerates, and limestones, some of which are magnesian, together with a series of lavas, ashes, and agglomerates of, as yet, unascertained thickness. The formation makes a prominent feature in the landscape of the district, and plays a very important part in the geology of the North-West. It may be followed from the Oakover River, across the upper reaches of the Nullagine, the Coongan, and the Shaw Rivers, as far as the western boundary of the goldfield, on the Yule River, near Cangan Pool. Areas of more or less extent make their appearance at Just-in-Time, Talga Talga, and North Pole, on the Shaw. The formation is of some economic value, by reason of the fact that the basal members of the series have proved to be auriferous in two localities, several miles apart, viz., Nullagine and Just-in-Time.

The Nullagine beds cannot be exactly correlated with any of those yet described in any of the previous official reports on the geology of Western Australia, owing to the absence of fossils throughout the series, wherever it has yet been studied. Under these circumstances, petrographical resemblance seems to be the only method by which any clue can, in the present condition of our knowledge, be arrived at with respect to its age. In its lithological characters and general behaviour it bears a very strong resemblance to the quartzites, etc., which constitute that continuous formation extending from Wyndham to Mount Hart, a prominent summit on the King Leopold Range in Kimberley, which have been claimed as Cambrian. If further research should indicate this resemblance to possess greater significance than at present appears, the Cambrian Age of the Nullagine series would have strong claims for consideration.

The Mosquito Creek Beds, which underlie the strata of the Nullagine series, comprise one of the oldest of the sedimentary formations as developed in Pilbara. The series consists of grits, shales and fine conglomerates, an approximate estimate of the thickness of which cannot be determined, though it is possible that the great thickness may be due to the repetition of the beds by folding.

What seems to be the base of the Mosquito Creek series is exposed a little to the east of Nullagine in what are known as the North and South Dromedaries. The range in which the beds are exposed consists of vertical beds of conglomerate of considerable thickness. The conglomerate is very much cleaved, and the cleavage planes are seen to cut through the centre of many of the quartz and other pebbles contained in it. The conglomerate contains numerous pebbles and boulders of laminated quartz (chert?),

belts of which form such conspicuous features in the Pilbara Goldfield.

No trace of fossils has been met with anywhere in the series, so no definite data as to the age of the Mosquito Creek beds is available. Observations in the field have shown that these strata lie with a violent unconformity beneath the Nullagine beds, and as in certain portions of the district the Mosquito Creek series have been subjected to more or less dynamical alteration, a considerable period must have elapsed between the deposition of the two series. The Mosquito Creek beds are of economic importance by reason of the fact that they form the matrices of the numerous auriferous quartz reefs which outcrop over a portion of the district, and have been more or less perfunctorily worked.

Warrawoona Beds.—In the neighbourhood of Warrawoona are a series of metamorphic rocks, which occupy a large area of country which forms a continuous belt from Marble Bar to Yandicoogina. These metamorphic rocks can be separated into two distinct sets, which are sharply differentiated from each other, viz., an acidic and a basic series.

The acid series is made up of highly siliceous beds, dipping at varying angles to the north-east and trending generally north-west and south-east. These beds, which there are very good reasons for believing to be of sedimentary origin, consist of fine-grained flaggy quartzites, sheared conglomerates, which still retain traces of their original character, mica and quartz schists, together with certain fine-grained siliceous rocks, which seem to have lost all trace of their original character. There are in intimate association with these certain other acidic rocks, which may eventually prove on closer examination to be highly-sheared felsites. The basic series occupy a large area of country and vary very much in the width of their outcrop. A very important feature in this series is the presence amongst the beds of a series of unfoliated rocks, which sometimes occur in the form of lenticular belts of, in certain cases, considerable horizontal extent. In one or two localities are belts of magnetite-schist, in the centre of some of which are uncrushed "eyes" of greenstone (of large dimensions), occurring in such a way as to indicate that the margins only have been crushed down into schist. The massive greenstones vary very much in grain; they all contain more or less hornblende and its numerous alteration products; some of its constituent minerals being largely replaced by carbonates.

These Warrawoona Beds are traversed by bands of laminated chert (?) which invariably occur in close proximity to, and in intimate association with, the auriferous quartz reefs.

The Warrawoona Beds are of considerable economic importance by reason of the fact that they carry all the auriferous reefs of Marble Bar, Salgash, Warrawoona, and Yandicoogina.

Granite and Gneiss.—The granite and gneiss, which occupies such an extensive area of country throughout the field, is almost everywhere seen to be intrusive into the oldest rocks of the district,

indicated as the Warrawoona Beds. In no case has the granite been noticed rising to the level of, and piercing the newer rocks of the Nullagine Series, hence its geological age can only be defined within certain limits. The granite is of importance in that it carries all the tin and tantalite veins of the district, the parent source of the detrital tin of Moolyella, Old Shaw, Cooglegong, and Wodgina. The rich quartz reefs of Boodalyerri, and some in the neighbourhood of Yandicoogina, occur in these rocks.

Dolerite, Diabase, and Gabbro Dykes.—A series of greenstone dykes have invaded all the other strata below the Oakover Beds in the form of dykes, which run in long and approximately parallel lines, and in many cases form very conspicuous features in the landscape, owing principally to their black weathered summits, which stand out in bold relief.

The dykes, which are all basic compounds, belong to two different periods. The newer basic dykes have a general north-east and south-west strike, and are often continuous for many miles. In many portions of the Goldfield the regular continuity of the system of dykes has been interrupted by faults, though no cases came under observation in which the horizontal shifting appeared to be very great. No very satisfactory evidence as to the age of these newer dykes has been obtained, though the Nullagine series in the vicinity of the township of that name is pierced by them, clearly indicating that their age is Post-Nullagine.

The older series of dykes have a general trend, which is approximately at right angles to that of the newer system. Like the newer dykes they are all basic compounds, and in many cases they have been more or less crushed and sheared into schistose greenstones. Owing to the marked features which many of the dykes exhibit on the surface, they have proved of considerable value in working out the geological structure of the district in at least two of the mining centres.

Economic Geology.

The Pilbara Goldfield contains several gold and tin-bearing areas, scattered over different portions of the district. Economically, the auriferous deposits have proved up to the present to be the most important.

Gold.—The geographical position of the various gold-mining centres shows a zonal development of the auriferous deposits.

From the result of the field observations, it appears that the auriferous deposits of the Pilbara Goldfield may be divided into six main and distinct groups, viz.:—

(*a.*) Lallarookh;
(*b.*) North Pole, Talga Talga, Bamboo;
(*c.*) Marble Bar, Warrawoona, Yandicoogina, Mt. Elsie, Boodalyerri;
(*d.*) Nullagine, 20-mile Sandy, Mosquito Creek;
(*e.*) Tambourah, Western Shaw; and
(*f.*) North Shaw.

The length of the Lallarookh Belt has not yet been defined, but it does not appear to be less than 30 or 40 miles. The North Pole, Talga Talga, and Bamboo Belt is 50 miles in length. The Marble Bar, Warrawoona, Yandicoogina, Mt. Elsie, and Boodalyerri Belt has a proved extent of about 80 miles. The Nullagine, Middle, and Sandy Creek zone is known to extend for a distance of at least 40 miles, and there are strong geological reasons for the belief that it continues much further to the east, and may possibly cross the upper reaches of the Oakover River. The Tambourah and Western Shaw Belt has not as yet been accurately defined, but it does not appear to be less than about 30 miles in length, whilst that of the North Shaw has only been proved to extend for a few miles.

The general direction of these auriferous belts almost everywhere coincides with the strike of the schists, which, with one or two exceptions, invariably form the matrices of the gold-bearing reefs. The prevailing dip of the belts coincides with the general trend of the main structural features of the district. Their width naturally varies, and in the three most northerly zones, the width cannot be defined owing to the fact that one of the boundaries is invariably marked by a powerful fault, which throws down the newer beds against the schists.

Quartz reefs occur in great abundance all through the schistose rocks, as well as to a more limited extent in the areas occupied by the granitic rocks. The quartz reefs are of two distinct types, viz.: white quartz reefs and laminated quartz and jasper veins, approaching very closely the hematite-bearing quartzites (?), which invariably form a conspicuous feature in most of the goldfields of the State. Some of the laminated quartz veins range from almost pure quartz, through banded jaspers, with crystals of magnetite, to bands appearing to the eye to be virtually pure hematite. Some of these —notably those in the Lallarookh Belt—could be readily concentrated to high-grade ores, which, under suitable conditions, might be turned to profitable account as sources of iron ore. The quartz reefs, of what may be called the massive type, occur plentifully in both the schists and the granites. They invariably occur along the planes of foliation (? bedding) of the schists, or, at any rate, cut them at a low angle.

The auriferous reefs cannot be said to be long, and are, as a rule, small, though they occasionally swell out into large lenticular masses. Some of the reefs have been traced along the outcrop for over 2,000 feet, and have swelled out to masses measuring about 15 feet across.

The value of any reef being in a large measure influenced by its richness and its quantity, *i.e.*, the thickness, length, and breadth of the shoots of gold, wherever possible, observations were made tending to throw any light thereon. So far as may be judged from the official returns from the various properties, it appears that the shoots of gold are rich, whilst the condition of the various workings implies that they are short.

The auriferous ores as a whole are of such a mineralogical character as render them readily amenable to battery amalgamation and cyanidation.

The following table shows the gold yield from the different mining centres of the Pilbara Goldfield up to the close of 1905:—

Table showing the Gold Yield of the various Mining Centres of the Pilbara Goldfield up to the end of 1905.

Group.	Mining Centre.	Ore crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom.	Average rate per ton.
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
(a.)	Lallarookh ... ... Ore ...	6,532·50	7,547·84	1·15	6,532·50	7,547·84	1·15
(b.)	North Pole ... ... Ore ...	416·00	277·02	·66			
	Talga Talga ... ... Ore ...	779·15	1,496·23	1·92			
	Do. ... ... Alluvial...	...	50·26	...			
	Do. ... ... Dollied ...	...	152·82	...			
	Bamboo ... ... Ore ...	10,791·25	17,519·49	1·62			
	Do. ... ... Dollied ...	...	119·70	...	11,986·40	*a* 19,292·74	1·61
(c.)	Marble Bar ... ... Ore ...	8,941·31	15,210·32	1·70			
	Do. ... ... Dollied ...	...	135·34	...			
	Wyman's Well ... ... Ore ...	233·40	734·69	3·14			
	Do. ... ... Dollied ...	...	11·32	...			
	Warrawoona ... ... Ore ...	7,155·76	15,552·90	2·17			
	Do. ... ... Alluvial...	...	44·30	...			
	Do. ... ... Dollied ...	...	335·73	...			
	Yandicoogina ... ... Ore ...	2,686·25	5,521·47	2·05			
	Do. ... ... Dollied ...	...	356·88	...			
	Mount Elsie ... ... Ore ...	508·25	1,560·28	3·07			
	Boodalyerri ... ... Ore ...	120·25	587·86	4·88			
	Do. ... ... Dollied ...	...	148·85	...	19,645·22	*b* 39,167·52	1·99
(d.)	Nullagine ... ... Ore ...	13,662·40	20,713·02	1·51			
	Do. ... ... Alluvial...	...	104·70	...			
	Do. ... ... Dollied ...	...	81·93	...			
	20-mile Sandy ... ... Ore ...	2,282·60	5,802·59	2·54			
	Mosquito Creek ... Ore ...	5,779·99	9,156·47	1·58			
	Do. ... ... Dollied ...	...	166·47	...			
	Sundry Parcels... ... Ore ...	38·50	2,393·22	6·21			
	Alluvial	...	1,529·32	...			
	Notices of Purchase ... Alluvial...	...	2,161·24	...			
	Do. do. ... Dollied ...	...	22·50	...	21,763·49	*c* 38,065·30	1·74
(e.)	Tambourah ... ... Ore ...	2,077·75	2,536·88	1·22			
	Do. ... ... Dollied ...	...	64·65	...			
	Western Shaw ... ... Ore ...	1,221·00	930·73	·76			
	Do. ... ... Dollied ...	...	4·77	...	3,298·75	*d* 3,467·61	1·05
(f.)	North Shaw ... ... Ore ...	351·45	674·72	1·91			
	Do. ... ... Alluvial...	...	7·53	...			
	Do. ... ... Dollied ...	...	567·06	...			
	Shark's ... ... Ore ...	6·00	33·00	5·50			
	Do. ... ... Alluvial...	...	145·08	...			
	Do. ... ... Dollied ...	...	15·17	...			
	Shaw River ... ... Ore ...	101·00	49·63	·49			
	Breen's Find ... ... Ore ...	14·00	66·82	4·77			
	Sundry parcels reported at Marble Bar* ... Ore ...	237·95	1,099·71	4·62	472·45	*e* 824·17	1·74
	Do. do. do. ... Alluvial...	...	4,109·29	...			
	Notices of Purchase reported at Marble Bar Alluvial...	...	1,435·44	...			
	Do. do. do. ... Dollied ...	...	202·52	...	237·95	*f* 1,099·71	4·62
	Total	...	...	...	63,936·76	*g* 109,464·89	1·71

* Localities not specified. *a* Not including 50·26ozs. alluvial and 272·52ozs. dollied. *b* Not including 44·30ozs. alluvial and 988·12ozs. dollied. *c* Not including 3,795·26ozs. alluvial and 270·90ozs. dollied. *d* Not including 69·42ozs. dollied. *e* Not including 152·61ozs. alluvial and 582·23ozs. dollied. *f* Not including 5,544·73ozs. alluvial and 202·52ozs. dollied. *g* Not including 9,587·16ozs. alluvial and 2,385·71ozs. dollied.

In addition to the gold derived from quartz reefs, the conglomerates at the base of the Nullagine series have in two localities, Nullagine and Just-in-Time, been mined, and the gold, as set forth in the tables below, obtained. It is noteworthy that the base of the series has only proved auriferous in those places where it lies upon that portion of the underlying formation which carries auriferous quartz reefs.

At Nullagine the auriferous strata occur through a thickness of about 300 feet of grits, sandstones, and conglomerate, which form the lowest portion of the series. The auriferous conglomerate is of sedimentary origin, and is made up of rounded and subangular fragments of the underlying strata. Those portions of the strata which have proved to be gold-bearing are those which are largely impregnated with the oxides and sulphides of iron, and which lie between a well-marked fault and a greenstone dyke. Mining operations have, up to the present time, been confined exclusively to the oxidised zone of the conglomerate and to very limited and shallow depths. The available evidence regarding the origin of the gold seems to indicate that it is a secondary and not an original constituent of the conglomerate; and owed its introduction to the percolation of mineral-bearing solutions down the most porous portions of the conglomerate, this condition being facilitated by the downward inclination of the bedrock, and possibly accentuated in part by the folding which the strata have undergone. Numerous dryblowers have been at work for a number of years over that portion of the conglomerate from which the crushings have been obtained, and have acquired a considerable quantity of gold, of which the published figures afford no clue. In all probability one half of the "alluvial" gold from Nullagine may be legitimately claimed to have been derived from the escarpment of the conglomerate.

At Just-in-Time, eight miles to the south of Marble Bar, another auriferous conglomerate at the base of the series has been worked. In many respects the auriferous conglomerate resembles the ferruginous bands as developed at Nullagine, and varies in thickness from an inch up to five feet in thickness. Certain portions of it contain a sufficient quantity of iron oxides to give quite a distinctive character to the rock. The auriferous conglomerate of Just-in-Time is, however, not of any very great horizontal extent, nor does it appear to penetrate to any considerable depth. As has been the case at Nullagine, the sloping ground at the foot of the escarpment has yielded considerable quantities of gold to the dryblowers, but, unfortunately, it did not appear to have been possible to keep a separate record thereof. Most of the gold obtained in this way owed its origin to the disintegration of the conglomerate.

Table showing the Yield of the Auriferous Conglomerates of the Pilbara Goldfield.

Mining Centre.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
Nullagine	5,167·00	3,217·29	·62
Just-in-Time	60·00	47·30	·78
Total	**5,227·00**	**3,264·59**	**·62**

Whilst the various tables above give fairly reliable data as to the production of the reefs and conglomerates, the amount of alluvial gold from Pilbara can only be roughly approximated. The large nuggets for which the district is famed are of distinctly local origin and are derived from the disintegration of quartz veins.

The auriferous zones of the Pilbara Goldfield resemble, in many important respects, the gold belts of the Murchison and the Eastern Goldfields of the State. Not only are the various rocks similar in character, but they may possibly be of the same geological age, whilst there is also the same linear persistence of the quartz reefs parallel to the general trend of the dominant structural features of the auriferous series.

Tin.—The tin deposits of the Pilbara Field, which have yielded 2,053·52 tons of tin, valued at £140,689, are, with one or two exceptions, all of detrital origin. The deposits extend over a wide extent of country, covering some hundreds of square miles, and have been actively exploited at several centres, many miles apart.

Lode tin is known to occur in the granite area of Moolyella; but, owing to the low percentage of cassiterite in the pegmatitic granite veins, it has not yet been worked. The bulk of the tin from this centre has been obtained from the alluvial deposits which form the existing valleys; they have, however, not been found to attain any great thickness, though their width, in some places, exceeds 10 chains. In addition to the alluvial deposits, a large quantity of residual tin, *i.e.*, ore derived from the decomposition of the tin-bearing pegmatites, *in situ*, occurs, and has been responsible for no small portion of the yield from Moolyella.

At Wodgina, which was discovered in 1902, the tin occurs in veins of pegmatitic granite, which penetrate a series of sedimentary and bedded igneous rocks, occurring along its flanks. Wherever these veins have been opened up, it is found that the tin occurs on either wall, in a band consisting of mica and tourmaline in varying proportions. The bed of the ravines, and the slopes on the hillsides, carry detrital and residual tin. The tin-bearing pegmatites are numerous, though it yet remains to be proved whether they can be profitably mined. This centre bids fair to rise in importance as a tin-producer.

Tantalum.—Tantalum-bearing ores have been worked at Wodgina, and up to the end of 1905 70·95 tons, valued at £8,925, have been raised. In addition to the alluvial and residual deposits, which have yielded by far the larger quantity of tantalite, the mineral has been found occurring in pieces of large size in one of the pegmatite veins which traverse the field. Much of the detrital tantalite results from the disintegration of the rich shoot in this vein. Having due regard to the uses to which the metal tantalum can be put, the discoveries at Wodgina are of importance, and there seem every reason for believing that the area over which the mineral occurs will be extended.

It may be noticed in this connection that the various tantalates and niobates of the rare earths, which exhibit marked radio-active properties, have been found to occur as primary constituents of such pegmatites as are met with at Wodgina; hence it is highly probable that careful search in the district may result in the discovery of the radio-active minerals, Thorianite, Fergusonite, Samarskite, Euxenite, etc.

Table showing the Tin and Tantalite Yield of the Pilbara Goldfield up to the end of 1905.

Mining Centre.	Tin.		Tantalite.	
	Ore raised.	Value thereof.	Ore raised.	Value thereof.
	tons.	£	tons.	£
Cooglegong	760·35	52,179	...	...
Moolyella	1,261·72	86,048	...	...
Old Shaw	145·34	10,530	...	...
Wodgina	31·45	2,462	70·95	8,925
Total	**2,198·86**	**151,219**	**70·95**	**8,925**

Diamonds.—The occurrence of small diamonds in the auriferous conglomerate at the base of the series at Nullagine has been noticed. At the present time, however, the interest is rather more scientific than commercial.

Iron.—Iron ores occur plentifully throughout the district. Many of those laminated quartz and jasper veins, notably in the Lallarookh zone, pass gradually into bands of what appear to the eye to be virtually pure hematite. Some of these deposits could readily be concentrated to high-grade ores. At present these are of course entirely beyond the reach of commercial enterprise, but, under more favourable conditions, there is little doubt but that some of them might be turned to profitable account as sources of iron ore.

Tungsten.—An ore of tungsten, scheelite (tungstate of lime), has been met with in the lode occurring in the Ard Patrick Mine at

Mosquito Creek. Two samples of this have been assayed in the Survey Laboratory, with the following results :—

(*a.*) 50·93 per cent. of tungstic acid ;

(*b.*) 45·1 per cent. of tungstic acid and 1dwt. 15grs. of gold per ton.

In both these samples, the comparatively low percentage is due to the admixture of a good deal of quartz with the scheelite. The mode of occurrence of the scheelite in the Ard Patrick seems practically identical with that in the Fraser's Mine, Southern Cross; Lindsay's Mine, Coolgardie ; and the Record Mine at Norseman. Scheelite is marketable, and in this case it is merely a question of concentration, provided the ore occurs in such quantities to make it worth the expense.

Asbestos.—Asbestos is known from the district in the vicinity of Tambourah, but in what quantity or in what mode it occurs there is no definite information, as no official inspection of the locality has as yet been found possible. So far as may be judged from the specimens [**1010, 6212**] at present in the Geological Survey Museum, the asbestos from Tambourah turns out to be fibrous chrysotile, identical with the Canadian mineral which is so much valued. The Tambourah asbestos, unlike most of the Australian mineral, has not the great defect of a low tensile strength, and in all the points—infusibility, softness, flexibility, fineness, and the ease with which the fibres can be separated—is well above the average.

Lead.—The occurrence of argentiferous lead ores is known from the neighbourhood of Tambourah, through specimens which have been sent in to the office for assay. No particulars regarding the ores are known to the Department than are to be gathered from the results of the official assays, which are as follow :—

Description of ore.	Lead per cent.	Gold. ozs. per ton.	Silver. ozs. per ton.
Cerussite, etc.	43·3	·736	22·69
Do.	60·1	nil	88·31
Galena	64·5	trace	68·75
Do.	68·8	trace	75·07

Future Prospects.

The attempt to forecast the future of any mining district is at all times a difficult matter, but more especially is it the case in any field where most of the mines are abandoned, full of water, or otherwise inaccessible.

A correct judgment of the future capabilities of gold mining in Pilbara cannot, however, be formed if the fact is ignored that the auriferous quartz reefs are of that somewhat irregular type described in the pages of various reports. The reefs, however, give

every indication of being permanent, whilst the average returns from the mines up to the close of 1905, have been, so far as may be judged by the figures furnished to the Mines Department, high, viz., 1·71ozs. per ton of ore milled.

Far less genuine and judicious prospecting appeared to have been done than the prospects of the field seem to warrant, for though the auriferous quartz reefs are irregular, they are numerous, and the wide-spread occurrence of quartz reefs, throughout the different zones in the district indicate perfectly clearly that the capabilities of the field, despite its relatively long existence, are by no means exhausted.

It seems, therefore, that the past history of gold mining in the district will be its future history, viz., the discovery of short, rich shoots in veins and reefs of the type described in the three reports, the exploitation of which seem best suited to the operations of small companies.

The auriferous conglomerates of Nullagine and Just-in-Time occurring at the base of such an extensive formation, though when looked at from a broad point of view, low-grade local deposits are of such a nature as would seem to encourage efforts in the direction of carefully prospecting other parts of the basal members of the series in the district. The area over which the formation extends is more or less accurately delineated upon the geological map of the field, which forms the frontispiece to this report, and should be of some assistance in this connection.

The very large area of intrusive granite in which tin has actually been worked at at least four localities, many miles apart, should encourage careful and judicious prospecting, more especially in those portions along the margin of the mass where it sends out veins into the surrounding rocks, and if intelligently carried out there is every probability that other tin mining centres will be discovered.

If prospecting and mining operations are carried out in the Pilbara Goldfield with due regard to the prevailing geological conditions, it may be confidently asserted that the district will continue to be a gold, tin, and tantalite producer.

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Government Geologist.

APPENDIX I.

Descriptive Register of Specimens from the Pilbara Goldfield (referred to in this report).

Registered No. of Specimen.	Registered No. of Microscopic Section.	Name.	Locality.
6452	658	Quartzite	Wodgina
6460	...	Quartzite (iron-bearing)	Wodgina
6496	687	Conglomerate (auriferous)	Just-in-Time
6497	688	Conglomerate	Just-in-Time
6461	663	Mica slate	Wodgina
6453	659	Greenstone	Wodgina
6486	679	Greenstone	South-east angle of Corunna G.M.L. 272
6491	684	Greenstone	
6492	685	Greenstone	Main shaft, Tambourah King, G.M.L. 252
6498	689	Vesicular andesite ...	Just-in-Time
6499	690	Andesite	Just-in-Time
6462	664	Hornblende slate	Wodgina
6485	678	Hornblende schist ...	Tambourah
6489	682	Greenstone schist ...	Government well, Tambourah
6487	680	Granite	Arrastra, Tambourah Creek
6488	681	Granitic schist	West of G.M.L. 274, Tambourah
6490	683	Granitic schist	Western Chief lease, G.M.L. 568, Tambourah
6466	...	Pegmatite	Bull's Lode claim, Wodgina
6479	672	Pegmatitic granite ...	Main Lode, Stannum mine, M.L. 77, Stannum Group, Wodgina
6474	669	Porphyry	Main Mass, Stannum, M.L. 77, Wodgina
6475	670	Porphyry	Main Mass, Stannum, M.L. 77, Wodgina
6476	671	Porphyry	Dyke in Greenstone, Stannum Group, Wodgina
6480	673	Felspar porphyry... ...	Dyke in Greenstone, Stannum Group, Wodgina
6455	661	Tourmaline rock	M.L. 89, Wodgina
6464	665	Tourmaline rock	Commonwealth, M.L. 85, Wodgina
6454	660	Blue quartz (quartz, lepidolite, and orthoclase)	M.L. 89, Wodgina
6456	...	Tourmaline in quartz ...	Wodgina
6457	662	Manganotantalite (lode)	M.L. 86, Wodgina
6458	...	Manganotantalite (lode)	M.L. 86, Wodgina
6470	...	Manganotantalite (lode)	Eadies' Claim, Wodgina
6459	...	Manganotantalite (detrital)	M.L. 86, Wodgina
6463	...	Cassiterite (lode) ...	Main lode, Cassiterite Mine, M.L. 84, Wodgina
6465	..	Cassiterite (lode)	M.L. 94, Wodgina
6468	...	Cassiterite (lode)	M.L. 84, Wodgina
6471	...	Cassiterite (lode)	Comet Mine, M.L. 80, Stannum Group, Wodgina
6472	...	Cassiterite (lode)	Stannum North Mine, M.L. 79, Stannum Group, Wodgina
6477	...	Cassiterite (lode)	Stannum Mine, M.L. 77, Stannum Group, Wodgina
6494	...	Garnet	Gadolinite lease, Cooglegong
6495	...	Gadolinite	Cooglegong
6467	...	Chloropal (var. pinguite)	Cassiterite Mine, M.L. 84, Wodgina
6478	...	Tourmaline (blue) ...	Tin lode, Stannum Mine, M.L. 77, Stannum Group, Wodgina

INDEX TO NAMES OF PLACES, MINES, REEFS, Etc.

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